The association between physical activity and vascular health in a cross section of older adults

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In New Zealand, the older adult population is the fastest growing age group, currently with 29,000 90 plus year olds, and it is projected to surpass 180,000 by 2060 (Stats NZ, 2019b). Older age is associated with frailty along with other health conditions such as heart disease, stroke, diabetes, arthritis and chronic pain (Ministry of Health [MOH], 2016b). Cardiovascular disease is the largest preventable cause of death in New Zealand, equating to 33% of the nation's deaths annually (MOH 2019a; Heart Foundation, 2020a). Cardiovascular disease includes heart, stroke and blood vessel disease, including hypertension (Heart Foundation, 2020b).

This cross-sectional study investigated the association between physical activity measured in MET minutes (MET-mins) and arterial stiffness using Pulse Wave Velocity (PWV). These two variables were then assessed for their association with health parameters including balance, aerobic capacity, quality of life (QOL), systolic blood pressure, hand-grip strength and leg strength in older adults living independently in retirement villages.

Pearson correlations indicated that four control variables (covariates) and three predictor variables were correlated to PWV: age (r=.50, p<.01), previously having a stroke (r=.33, p <.05), heart incident (r=.31, p <.05), healthy diet (r=-0.23, p <.05), brachial systolic blood pressure (r=.50, p<.001), leg strength (r=-.23, p<.05) and aerobic capacity (r=-.19, p<.05). In addition, MET-mins were correlated to age (r=-.46, p<.001.), stroke incident (r=-.27, p<0.01), balance (r=-0.32, p<.05), aerobic capacity (r=0.24, p<.05), and lower brachial systolic blood pressure (r=-.22, p<.01).

Four QOL variables were correlated to MET-mins: physical functioning (r=.34, p<.0001), general health (r=.29, p<.005), role limitations due to emotional problems (r=.28, p<.006), and limitations due to physical health (r=.24, p<.022). Three QOL variables were correlated with PWV: limitations due to physical health, (r=-.27, p<.015), limitations due to emotional health (r=-.24, p<.027), and physical functioning (r=-.22, p<.05).

When analysed as multiple hierarchical regression, age significantly predicted PWV, along with heart incident and stroke when all four covariates were used in Model 1. There was a negative correlation between PWV and METs (r=-.31, p<.05), a medium effect size, with a lower PWV score, correlated with a higher score of total METs for participants. PWV mean was 11.9 ± 2.4 and the participants' mean METs minutes per week were 4557.8 ± 2836.22 resulting in 99% of this population meeting or exceeding guidelines as recommended by the Physical Activity Guidelines Advisory Committee (2018), the World Health Organization (WHO, 2011) and the New Zealand Older Adults Guidelines (MOH, 2013).

As the population gets older in New Zealand (and globally), it is important to have an understanding of preventative healthcare. Then the ageing population is ensured that their longer life expectancy can be lived to the fullest without those increased years being affected by ill health (MOH, 2011). However, an important suggestion could be to ensure retirement villages are giving their residents every opportunity available to be active and stay active in their ageing years.

Keywords: Older adults, physical activity, health, metabolic equivalents of task (METs), MET- minutes (MET-mins), vascular health, hypertension, pulse wave velocity (PWV), arterial stiffness, quality of life (QOL), strength, balance, physical inactivity, chronic disease, physical activity guidelines.

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Table of Contents

List of Tables

Chapter 1

Introduction

Globally, the population in most countries is ageing, and life expectancy for individuals continues to rise (increased by 5.5 years between 2000 and 2016) (World Health Organisation [WHO], 2020a), now people are expected to live into their sixties and well beyond (WHO, 2018). This is no different in New Zealand and in recent years, it has been recognised that New Zealanders are living longer, with data from Stats NZ from 2016-2018 showing the average life expectancy from birth is 80.2 years for males and 83.6 years for females (Stats NZ, 2019a). A longer life can also be associated with other problems, with the Ministry of Health (MOH, 2016a) recognising that New Zealanders later years are commonly affected with a range of disabilities.

Longer life (as life expectancy increases), also brings more time for opportunity but what opportunities are taken up, however, may depend on the health of the individual. Older age is also associated with frailty and other adverse health conditions which can be debilitating such as heart disease, stroke, diabetes, arthritis, and chronic pain (MOH, 2016b). These conditions are more prevalent in older adults aged 65 years plus and the prevalence of each of these conditions increases as a person ages (MOH, 2018a). If a person's older years are dominated by declining physical and mental health, the ramifications for those older adults and society, are expected to be more negative (MOH, 2016a).

Cardiovascular disease is the largest cause of death in New Zealand, equating to 33% of the nations' deaths annually (MOH, 2019a; Heart Foundation, 2020a). Cardiovascular disease includes heart, stroke, and blood vessel disease, including hypertension (high blood pressure), often known as the 'silent killer' (Heart Foundation, 2020b). For most, it can go undetected with people not experiencing or recognising the signs or symptoms, and the only way to identify any issues is by having regular blood pressure checks with a General Practitioner and being aware of the risks (American Heart Association, 2017).

Evidence suggests that in both older male and female adults, those who are physically active compared to those who are less physically active, show a higher level of cardiorespiratory and muscular fitness, while also sharing lower rates of mortality, with reduced incidence of heart diseases, diabetes, some cancers, better bone health, reduced risk of falls and better cognitive function (WHO, 2020b). The Heart

Foundation (2020c) suggests that even if one does not start exercising until middle age that every hour of exercise can equate to gaining approximately two hours of additional life expectancy.

However, the statistics suggest that sedentary behaviour increases with age and is more likely for those that are in residential care, than those who are living in the community (MOH, 2013). Furthermore, being physically inactive increases the risk of heart disease and stroke by 50% (Heart Foundation, 2020c).

Currently, with one New Zealander dying every 90 minutes from some form of heart disease and with an increasingly older population (MOH, 2019a; Heart Foundation, 2020a), there is a growing need for research in this area. This cross-sectional research study investigated the association between physical activity measured using MET minutes (MET-mins) and Pulse Wave Velocity (PWV) with a variety of health parameters including balance, cardiovascular fitness, quality of life (QOL), vascular health, grip, and leg strength in older adults. Participation in this study entailed the measurement of vascular health including blood pressure and PWV, a non-invasive measurement completed with a SphygmoCor Xcel, which measures the blood flow velocity (the gold standard in vascular health) and the augmentation index (arterial stiffness). Physical activity was measured in Metabolic Equivalents of Task (METs), more specifically MET-minutes (MET-mins) which is an index of energy expenditure associated to particular activities and the amount of time they are performed (American College of Sports Medicine [ACSM], 2014). MET-mins was the measure of physical activity used to determine its association with the multiple health parameters as listed above, including strength, balance, cardiovascular fitness, and quality of life.

The findings of this research aimed to inform the recommended levels of physical activity for older adults and has identified the strength of the relationship between MET-mins, PWV and other health parameters in this population, which can help increase our understanding of the association between vascular health and physical activity for older adults.

This thesis contains an overview of the literature on older adult's health along with associations between older adults' health and the measurements to be used in this thesis, including PWV, MET-mins, balance, cardiovascular fitness, quality of life and strength followed by a description of the methods used to conduct this research. The results and discussion follow in the subsequent sections, along with a detailed description of the findings and further research implications for this population.

Chapter 2

Literature Review

2.1 Ageing Population

The 2018 New Zealand census data showed that there are over 700,000 people who are 65 years or older (Stats NZ, 2019c). Today's older adult population is the fastest growing age group in New Zealand with the number of people aged 65 years likely to double to between 1.3 and 1.5 million by 2046 (MOH, 2016a; Stats NZ, 2016). As a result, the older adult population is growing faster than the younger population in New Zealand (MOH, 2016a, 2018a). In 2016, the population who were aged over 90 years reached 29,000 and will continue to grow to approximately over 180,000 by 2060 (Stats NZ, 2019b). As life expectancy increases, health researchers continue to investigate behaviours that improve the quality of life as well as physical and functional abilities of the ageing population (Lima, Barros, Cesar, Goldbaum, Carandina & Ciconelli, 2009). Understanding how lifestyle physical activity correlates with vascular health, balance, cardiovascular fitness, quality of life, and strength can help determine the role in which physical activity is most important for older adults.

2.2 Physical Activity Recommendations

At present, the current physical activity recommendations for older adults (those aged over 65 years) are the same as those for adults (aged 18-64) regarding aerobic duration. Nevertheless, research suggests that ageing plays a role on physiological health and other health parameters, including lower maximum cardiac output, lower maximum heart rate, higher resting and exercise blood pressure, lower muscular strength, and slower reaction time (Skinner, 2005). Given the rapidly growing and ageing population and the fact that physical inactivity is one of the leading risk factors for global mortality (WHO, 2020c), physical activity recommendations may require unique specification for older adults as opposed to adults aged 18-64 years.

The physical activity aerobic recommendations and durations set forth by the WHO for ages 65 plus are:

> "Older adults should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or, at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or, an equivalent combination of moderate- and vigorous-intensity activity (7.5 metabolic equivalent hours per week)" WHO (2011, 2018), which equates to 450 MET minutes per week.

A review of the 2018 Physical Activity Guidelines Advisory Committee Scientific Report, shares similar recommendations and states that either 150-300 minutes per week or the equivalent of 500-1000 MET minutes per week are recommended for potential benefit or risk reduction (Physical Activity Guidelines Advisory Committee, 2018). These requirements are slightly higher than those listed above as per the WHO (2011, 2018).

2.2.1 Guidelines in New Zealand

Similar to the guidelines above, the New Zealand MOH (2017, 2018b) recommends that older adults be as physically active as possible and encourages any 'movement as an opportunity'. This is especially important for older people, and they are further encouraged to reduce sedentary behaviour and increase their physical activity levels. Their Guidelines on Physical Activity for Older People (aged 65 years and over) are:

> "Aim to do aerobic activity on 5 days per week for at least 30 minutes if the activity is of moderate-intensity; or for 15 minutes if it is of vigorous-intensity; or a mixture of moderate- and vigorous-intensity aerobic activity" (MOH, 2017).

In addition, older adults are encouraged to partake in three sessions of flexibility and balance and two sessions of muscle-strengthening activities per week (MOH, 2018). Within the New Zealand Guidelines, it was further suggested that older people should aim to accomplish double the recommendations if they are already meeting requirements (MOH, 2018) and it is recommended for additional health benefits older adults should aim to complete:

> "60 minutes of moderate-intensity aerobic activity on five days per week, 30 minutes of vigorous-intensity aerobic activity on five days per week, an equivalent amount of combined moderate- and vigorous-intensity activity per week" (MOH, 2013).

Results of the 2011/12 New Zealand Health Survey (MOH, 2012), reported that older adults were the least likely group to meet any of the New Zealand Physical Activity Guidelines, and the least likely to meet any guidelines that relay health benefits. This survey reported that inactivity increased at aged 65 years or older, and again after 75 years where 30% of men and 40% of women were participating in less than 30 minutes of physical activity per week. These changes resulted in a considerable proportion of older adults who reported that they do not reach the recommended daily physical activity time, even when spread out over a one-week period. The Active NZ 2017 Participation Report (Sport New Zealand, 2018) had similar findings, noting that participation in sport declined after the age of 65 in the wider population. However, this report did not include data relating to the daily physical activity guidelines and recommendations.

2.3 Exercise and Health

The extant literature provides strong evidence that physical activity has many benefits. Among the elderly, physical activity has been linked to slowing the negative effects of age-related changes in body composition, psychological wellbeing, longevity, chronic disease, and disability (ACSM, 2014). Work from Lima et al., (2009) suggests the link between increased age and lower perceived quality of life measures can be attributed to the decreased ability to use the body through age-related changes later in life such as reduced mobility and body functions.

The MOH (2016b) indicated that health conditions and debilitating diseases increase with age, such as osteoporosis, diabetes, stroke, heart disease, chronic pain, and conditions like arthritis. These conditions can be due to the impact of age increasing sedentary behaviour of individuals along with the declining capability to carry out physical activity and daily lifestyle activities (MOH, 2006). Evidence suggests that along with additional health benefits, exercise is also an important strategy for helping manage the pain of disabilities such as arthritis as it will help keep the body moving, reduce pain, restore flexibility, and protect joints against further damage (Arthritis NZ, 2020).

2.3.1 Exercise and Mental Health

Mental health issues in older adults are expected to increase due to the demographical changes, with more people living longer and more people experiencing mental health problems, addiction, or dementia (MOH, 2011). Over half of New Zealand’s older adult population experiences loneliness, caused by social isolation, death of a spouse or limited mobility function, and approximately 9% of older adults feel lonely all the time (Ministry of Social Development, 2016, 2020). Loneliness is also associated with lower physical and mental health in older adults (Coyle & Dugan, 2012). Cornwell & Waite (2009) analysed data from a national longitudinal study representing American older adults and found that within the population of community-dwelling residents that lower levels of self-rated health were independently associated with social disconnectedness and perceived isolation. In addition, the study by Tiemiers, Breteler, Hofman & Witteman (2003) showed that increased arterial stiffness (measurements taken from the carotid artery/femur) were associated with higher rates of depression later in life.

Not all older adults suffer from poor mental health. Those in community-dwelling and retirement villages could be less susceptible to mental health problems than older adults living alone. Retirement homes can offer social environments as well as many organised activities which include physical activities such as fitness courses but also gardening, bowls, swimming, shopping, and more. The benefits of physical activity have been found to be greater when completed in a group setting, as it is increasing social interactions, which is another important factor for older people's mental health (MOH, 2013). Social interaction can help psychological wellbeing (Yale Medical Group, 2012, as cited in MOH, 2013). Studies have shown that if older people choose activities, they enjoy with friends or family, it is more likely they will continue to participate (MOH, 2013).

Additionally, the New Zealand General Social Survey of 2014 (Stats NZ, 2015), showed that older people (aged 65 and over) were more likely to be satisfied (89.9%) and have a greater sense of purpose with their lives (85.9%) than younger age groups (Stats NZ, 2015). These results could be attributed to having a better balance (of work and recreation), financial security and having already raised their families (Stats NZ, 2015). Sattelmair, Pertman, & Forman (2009), reported that older adults with higher physical activity levels also had a higher perceived quality of life. Further to this, a MOH (2018) study suggests methods of avoiding long-term health problems and the burden of cognitive impairment and depression (Knapen, Vancampfort, Morien & Marchal, 2015; Lautenschalger, Almedia, Flicker & Janca, 2004) can be as simple as eating healthily, decreasing alcohol consumption, and participating in regular physical activity. According to the MOH (2013), undertaking 60 minutes of physical activity each day can provide improved mental wellbeing.

2.4 Arterial Stiffness

The health of arteries and veins, like most tissues, deteriorate with age as per the natural ageing process. Arteries which are usually dynamic and soft in young people change over time and become stiff pipelines in most elderly people (Sattelmair et al., 2009). The stiffer the arteries, the more pressure that is put on the heart to pump the blood around the body, as the vessels are less compliant and do not stretch to accommodate the blood flowing. As a result of this stress, other vascular and cardiac health issues can be accelerated (Sattelmair et al., 2009). Research indicates that the natural and progressive stiffness of the arteries is more frequent after the age of 40 years, and older sedentary people have increased central arterial stiffness (Shibata et al., 2018). However, Sattelmair et al., (2009) found that in some cross-sectional studies, the individuals who participated in habitual aerobic exercise had slower progression of the arterial stiffening than their sedentary peers. Therefore, exercise has been attributed to reducing arterial stiffness in older adults.

Pulse Wave Velocity (PWV) is a vascular health measure of the velocity of the blood flow, and it has been identified as a precise, valid, and reliable way to estimate the arterial stiffness (Doupis, Papanas, Cohen, McFarlan, & Horton, 2016). This measure is considered to be the gold standard in non-invasive vascular health measurement (SphygmoCor XCEL, 2012). Pulse Wave Analysis (PWA) is used to assess the central blood pressure and stiffness of the arterial system, it is also used to evaluate the arterial ability and is often easier to assess than PWV (Doupis et al., 2016). PWA can measure markers such as pulse pressure, augmentation pressure and augmentation index and is also considered to be a reliable measure of the resistance of the vessel. Age is also known to be a major determinant of both the PWA and PWV measurements, as the expected stiffening of the arteries is a natural process of ageing (Sattelmair et al., 2009; Shibata et al., 2018). The stiffening of arteries can lead to hypertension, cardiovascular disease, and risk of stroke, all of which can be debilitating (Heart Foundation, 2020b).

2.4.1 Exercise and Heart Disease

Habitual exercise, along with a high volume of aerobic activity in older adults, has been shown to preserve vascular health, thus lowering the risk of vascular disease and stroke (Sattelmair et al., 2009). Ageing is an uncontrollable factor which influences a person’s risk of developing cardiovascular diseases (Heart Foundation, 2020b). Regular exercise also reduces coronary heart disease, the risk of hypertension and other vascular diseases along with preserving muscle mass and function while ageing (Nelson et al., 2007). A study by Shibata et al. (2018) showed that exercising four to five times a week for approximately 30 minutes each bout over a lifetime has favourable effects on arterial ageing. However, less frequent lifelong exercise, including up to two or three times a week, was also associated with decreased arterial measures, showing less frequent lifetime exercise can also be associated with better arterial health (Shibata et al., 2018).

There are some uncertainties regarding vascular health and physical activities, (Lacey et al., 2015) particularly around the strength of the association between physical activity measured as Metabolic Equivalents of Task (METs) and vascular disease. Armstrong, Green, Reeves, Beral, & Cairns (2015) indicated that vascular risk could also increase with daily strenuous physical activity in women, but this has yet to be confirmed in other studies. Therefore, further research is needed to determine the association between MET-minutes and vascular health in older adults specifically.

2.5 Cardiovascular Fitness

Cardiovascular fitness is essential for the vascular health system and is also an important determinant for health as we age. Improved bodily functions through physical activity include increased lung and heart capacity and function (ACSM, 1998). Typical measures of cardiovascular fitness include maximal and submaximal exercise tests which measure the aerobic performance of the individual or the physiological change during the test. One such test is the six-minute walk test, which was created in 1963 by Balke, and is commonly used in pulmonary rehabilitation (Solway, Brooks, & Lacasse, 2001) particularly among sometimes frail and physically limited elderly to detect and predict cardiorespiratory health and is a functional exercise for daily activities in healthy older adults (American Thoracic Society, 2002). A six-minute walk test is also used to assess aerobic endurance, which is increasingly important for older adults for daily activities such as shopping and walking around the home (Jones, & Rikli, 2002). The six-minute walk test is used for pre-and post-operative evaluation of pulmonary and cardiac disease, interventions, and treatments (American Thoracic Society [ATS], 2002). However, there are also various studies which have investigated the six-minute walk test in fit or healthy older populations. A study by Camarri, Eastwood, Cecins, Thompson, Jenkins (2006) tested the six-minute walk test in a group of 'healthy subjects' aged 55-75 years old and found that the distance completed within this group were higher than those previously reported in other studies. While Bohannon (2006) performed a meta-analysis of 13 studies using the six-minute walk test summaries, aiming to generate normative values that could be used for those aged 60 years or older. Bohannon (2006) concluding that the 'norms' should be gathered from a large random, healthy population and then those results should be standardised using procedures set forth by the ATS to generate norms for the six-minute walk test. Benavent-Caballer, Lison, Rosado-Calatayud, Amer-Cucenca & Serurga-Orti (2015) researched the six-minute walk test between community-dwelling and nursing home residents (healthy populations of both), their results found that there were different predictors influencing the distanced travelled within both populations. Within the community, better low limb function, mobility and balance predicted higher distance on the walk test. Similarly, for the nursing home residents, the bigger distance was predicted by lower limb function and mobility. These latter studies demonstrating that the six-minute walk test can also be used as a functional fitness test for older adults who are not necessarily recovering from heart incidents.

2.6 Muscular Strength and Physical Activity

Muscular strength has been found to decrease 15% every ten years of life during the sixth and seventh decades of life, and then 30% every ten years thereafter (Mayer et al., 2011). As muscular strength is decreased tasks and activities that are physical can become increasingly difficult to manage. Physical activity can improve bodily functions (through an improved vascular system), as well as mobility improvements and further muscular development (ACSM, 1997). Clinical tests such as the chair sit-to-stand test and grip tests in older adults are assessment tools used to evaluate the strength of the lower and upper body. The chair sit-to-stand test requires one to repeatedly stand up from and sit down onto a chair for 30-seconds, and the number of completed sit-to-stands is recorded. This test reflects lower body strength in the older adult population (Langhammer & Stanghelle, 2015). Lower body strength is vital for older adults as is needed for numerous functional and everyday tasks such as getting out of a chair and moving upstairs (Jones & Rikli, 2002). The chair sit-to-stand test can be useful in detecting early onset decline in independence (Millor, Lecumberri, Gómez, Martínez-Ramírez, & Izquierdo, 2013). Grip strength is another valuable tool to test in older adults and can be predictive of various health conditions (Angst, et al., 2010; Bohannon et al., 2006). Some longitudinal studies showed that lower hand-grip strength is indicative of increased mortality from cardiovascular diseases (Gale et al., 2007). The hand-grip strength test is a reliable measurement, even when different protocols and assessors are used (Fess, 1992). Habitual physical activity plays a big role in preserving muscle mass, and function in old age. Strength training studies have produced results of increased strength and muscle function and even reduced frailty in the elderly, suggesting that physical activity is linked to lifestyle daily activities and tasks (Sattelmair et al., 2009). Muscular strength is a major health variable in older people and being physically active helps maintain strength alongside muscle preservation. Increased muscular strength improves the control of movement, which can result in a decrease in the risk of falls in the elderly.

2.7 Falls prevention and balance

Unfortunately, falls are also common in people aged 65 years and older. Ageing causes a functional decline in several body systems, including muscular strength, balance, and reaction speed (Sattelmair et al., 2009; Nelson et al., 2007), all of which can result in an increased risk of falls and fall-related injuries. These falls can result in pain or discomfort, injury, decreased wellness or wellbeing and in some cases death (Accident Compensation Corporation [ACC], 2007). To reduce the risk of injury and falls, it is recommended that exercises which maintain balance should be performed. Further, the MOH (2013) recommends that frail older adults should aim to complete a mixture of low impact activities in place of the aerobic guidelines and partake in flexibility, balance, and resistance activities. A systematic review of fall prevention programmes indicated that there is a need for participants to attempt moderate to highly challenging balance exercises on an ongoing basis for further improvement in their balance (Sherrington, Tiedemann, Fairhall, Close, & Lord, 2011). The Otago exercise programme to prevent falls in older adults (ACC, 2007) is one example of how specific exercises developed for the elderly to increase balance and stability and to reduce falls can result in a decrease in injuries. The programme was successful, reducing the number of falls and the number of injuries resulting from falls by 35% and was equally as effective for men as for women.

The four-point balance test derived from STEADI (Centers for Disease Control and Prevention [CDC], 2017) is commonly used for evaluating fall risk (ACC, 2007). Research has shown that older adults (aged 65 plus) who cannot successfully reach a level 3 on the ACC balance test (a stance with one foot positioned on the floor in front of the other foot) are at an increased risk of falling (CDC, 2017). Therefore, by assessing balance alongside MET-minutes, it is possible to identify the relationship between balance capability and physical activity levels as research has already indicated being active helps maintain balance, and therefore mobility and health in older adults.

2.8 Older Adults Diet

Problems that older adults face in relation to nutrition and eating well can vary from budget woes, difficulty shopping, medications, and mouth or denture issues (NZ Nutrition Foundation, 2018). However, nutrition (alongside physical activity) is still important for older adults, as they can delay or even reverse those declines associated with ageing (NZ Nutrition Foundation, 2018). Diet and regular exercise play a large part in keeping a healthy lifestyle, maintaining a healthy weight, and reducing the risks of obesity and other diseases. A poor diet can also be further linked as an influencing factor for diabetes and high blood pressure, which additionally can attribute to heart disease and stroke (MOH, 2016b).

In addition to physical activity helping reduce disease prevention, diet is also important in maintaining cognitive function (Hart, Milte, Torres, Thorpe, & McNaughton, 2019). Further, diet may have an influence on the quality of life and mental health as research by Hart et al. (2019) found associations with unhealthy diet patterns and higher depressive symptoms in Australian women (but not in the men who were observed). Therefore, it seems diet has an important role to play in older adult's health to improve health outcomes including the physical, mental, and physiological and seems essential to make sure it is balanced and monitored to the individual's needs.

2.9 Metabolic Equivalents of Task (METs) and Older Adult Health

Metabolic Equivalents of Task (METs) are frequently used to describe exercise intensity, one MET minute is the energy expended equivalent of one minute of seated rest (ACSM, 2010). Furthermore, METs are a standardised way to describe the absolute intensity of a variety of different physical activities, from light to vigorous activities (WHO, 2011; ACSM, 2010).

There is a dearth of knowledge regarding how many cumulative MET minutes of exercise plus lifestyle-related physical activities are required to provide specific health benefits (i.e. vascular, strength, balance, quality of life) in older adults (Lacey et al., 2015). Moreover, Lacey et al. (2015) measured the relationship between the volume of physical activity and major vascular events over a long period of 11± 4 (M, SD) years. However, their study only measured recreational physical activity, and it excluded lifestyle physical activities (i.e., gardening, walking to visit friends, shopping, cleaning, etc.). The proposed study in this thesis is unique, and it will expand upon Lacey et al. (2015) findings as it has investigated the association between individual arterial stiffness and aggregated weekly MET-mins using all types of physical activity engagement among older adults living independently in a retirement village. MET-mins will be accumulated via the YALE Physical Activity Survey (YPAS), a survey regularly used to determine the physical activity of older adults. The results may help to identify which level of physical activity MET-mins best aligns with individual health parameters in older adults.

2.10 Health of Older Adults in Retirement Villages

As reported by JLL in 2019, in New Zealand, there are over 31,500 retirement village units and 13% of these are located in the Canterbury region and considering the ageing population of New Zealand, the capacity for retirement facilities is expected to increase. In New Zealand, it is also important to note that there are different types of retirement care facilities, residential care which encompasses four different options (rest homes, long-stay hospitals, dementia units and psycho-geriatric units), additional to these care options are retirement village alternatives (MOH, 2019b). Retirement villages differ as they are not the same as residential care. Villages allow for long-term care in hospital or rest homes, and well as individual living options. Individuals are encouraged to look at their health status when looking at retirement options, as increasing health needs can have a factor in their (or their families) decision.

The MOH (2006) found that people who are living in residential care are likely to be more sedentary than those living in the community. Frailty is also linked to those living in residential care, and fear of falls along with ageing rehabilitation can be a consideration when choosing to move into rest home options rather than staying in the community. The WHO (2018a), established that, for older adults, the physical and social environment, and whether they feel supported in these environments, has a big impact on whether they are involved in activities.

However, there does not seem to be large amounts of research completed which have been based on retirement communities and the health of these residents. This study focused on residents in retirement villages, who are living independently, including residents in either a unit or townhouse but did not include any participants who were based in rest home or respite care.

2.11 Conclusion

From an analysis of the literature, it is apparent that many health benefits that come from exercising regularly. However, there is a lack of research surrounding retirement community living especially and the health of those participants compared to those living independently in the community (or in rest home/respite care). More important, given the rapidly ageing population there is need to assess the health variables of this population to ensure that their longer lives can be enjoyed and lived to the fullest, without the burden of pain, disease, and disability. This study used MET-mins to calculate physical activity levels of the participants and will further be unique by assessing PWV, the Gold Standard for arterial health, to the predict stiffness of arteries with other health parameters.

2.12 Research Questions

The aim of this research was to identify the association between MET minutes and/or arterial health PWV with individual health parameters in older adults. The study aimed to determine this by answering the following two research questions:

1. What is the strength of the association between MET minutes and a) vascular health, b) strength, c) balance and d) quality of life?

2. What is the strength of the association between PWV and a) METs, b) strength, c) balance and d) quality of life?

The overall outcomes from this research are to determine the relationship between MET-minutes and PWV with a) vascular health, b) muscular strength, c) balance and d) quality of life in an additional objective is to inform the recommended levels of physical activity for older adults as identified by the relationships above.

Chapter 3

Methods

3.1 Introduction

This study was comprised of participants residing in Canterbury who were 65 years or older and currently living independently in a retirement village or organisation. This cross-sectional study compared the relationship between physical activity (MET-mins) and vascular health (PWV) with a range of other health indicators.

3.2 Design

This quantitative study was cross-sectional in nature, and the data were collected by convenience and snowball sampling over 12 months. The nature of this study recruitment method lends itself to a self-selection bias, whereby it could be more likely that people who are already quite physically active would be more motivated to participate. The following physical health parameters were collected: height, weight, blood pressure, resting heart rate, aerobic capacity, strength, and vascular health, along with a range of small health-related questionnaires. The type of data that were collected included self-reported physical and mental health using questionnaires as well as physiological measurements on the participants.

3.2.2 Survey Design

Four self-reported questionnaires were used to assess multiple components of the participant's health within one combined survey. First, 17 questions about demographic information such as age, sex, and ethnicity were collected. The YALE Physical Activity Survey (YPAS) was the second part of the survey and contained 48 items on daily physical activity levels. Thirdly, the 36-Item Short-Form Health Survey (SF-36), which contained 36 items and measured eight health concepts and an additional single item to provide an indication of perceived health (Rand Corporation, 2018). The SF-36 is drawn from the Medical Outcome Study and is widely used to analyse health-related quality of life outcomes (Lima et al., 2009). The final part of the survey and the fourth questionnaire contained 10 items on nutrition from the 'Your Disease Risk Index', a diet-related questionnaire. The YPAS was selected to be used in this study as it is both reliable and validated, and the questions were designed to assess participants physical activities in a quick manner (Dipietro et al., 1993). It also includes age-related questions and encompassed important lifestyle (domestic, leisure time and exercise) related questions around physical activity for seniors (Ruiz-Comellas, 2014), which are relevant for this study and important to understand within an older adult's overall health assessment. The SF-36 has been validated in multiple cultures (Lima et al., 2009) and has acceptable reliability.

3.3 Sample and Location

This research compared the relationship between physical activity and vascular health among Cantabrian participants aged 65 years or older living in a retirement village or community. Given, the cross-sectional nature of this study and the large number of variables assessed, a sample size of 200 would be conducive to achieve a power level which limits the possibility of a Type II (Beta) error, (Walmsley & Brown, 2007). Due to unforeseen circumstances, however, after a large retirement community establishment enrolled then unenrolled in the study along with a limited timeline of the researcher, the researcher was forced to seek participants in smaller retirement communities. As a result, there was limited time to recruit the desired sample of 200 participants resulting in a much smaller than ideal sample size.

Data were collected via the convenience sampling method, and although the aim of the study was to collect data from 200 participants, however, the final sample size stood at 95 participants (N=95). Although a convenience sampling method was used to recruit participants, there was also evidence of self-selection bias through this study, and it was not randomised. All three villages where the participants lived were located in Canterbury, and all of the 95 participants signed up on their own accord after hearing about the study from numerous sources, including posters, notice boards, information sessions, the village manager and word-of-mouth, which does indicate the method also showed evidence of snowball sampling.

Data collection were completed at three independent retirement villages over a twelve-month period, starting late January 2018 until the end the of December 2018. Some secondary data (re-testing) were collected from one of the villages again at a later date due to some error on vascular health scores. Once those identified participants were re-tested, their data set was able to be completed. However, some of the participants were still missing parts of their vascular health scores due to errors when completing the tests. The sample size of 95 consisted of 52 participants from village 1, another 6 participants from village 2 and the final 37 participants from village 3. There was a small participant drop-out during the data collection, with a total of three people who expressed their interest initally in the study, but then changed their mind and chose not to participate when appointments were being confirmed. In addition, there were some participants that only completed certain parts of the full assessment due to a range of extraneous personal circumstances, one person did not complete the full six minutes of the walking test (but data were still collected), one did not complete the survey, and a further two participants who only completed the survey (and did not partake in the physiological testing). Furthermore, there were several subjects whom the researcher could not collect a full set of vascular data (as mentioned above). The total number of subjects who had fully completed data sets in this sample was 80.

3.4 Procedure

The researcher first contacted the identified retirement village managers in Canterbury, some with little success. The manager of the facility was first emailed, and if no response was received, they were then followed up with a second email and a phone call (as seen in Appendix A). If there was interest shared for the study, the researcher met with the manager or administration of the retirement home to discuss how the study would work specifically in their retirement village. If the management was willing to continue with the study and once official permission was gained from the village, a flyer was then sent to the manager of the retirement home and asked to be distributed in newsletters and on noticeboards within the facility (as seen in Appendix B). In all villages, the flyers were distributed door-to-door to the independent residents. The management and researcher’s details were available on the flyer for interested parties who would be requiring further information.

At two of the retirement villages, the researcher was asked to hold an information session to discuss the upcoming study with residents of the retirement complex, and this allowed the residents the opportunity to ask questions about the study and to sign up on the spot. Participants were self-selected by responding to public invitations in their village to participate in the study. The participants included older adults who had contacted the researcher either in person, at an information event, by email or phone who were then filtered by the inclusion criteria as listed in the Research Information Sheet (RIS) (as seen in Appendix C).

If interested parties were willing to continue and were within the inclusion criteria (listed below) then, the participants were sent the RIS, the informed consent form (as seen in Appendix D) and the physical activity readiness questionnaire (PAR-Q) (as seen in Appendix E) along with the physical health questionnaires (demographics, YPAS, SF-36 and diet) (as seen in Appendix F) before their scheduled appointment. The information was either hand delivered to their residential home a couple of days before their appointment or was left with the management and/or administration at the villages for the participants to collect.

During the appointment, the researcher would first go over the forms and surveys to check they had been completed correctly and asked for clarification at some points. Some participants did not complete the questionnaires and forms before their appointment. In such cases, the researcher would complete the forms with them. There was only one subject whose physical health questionnaires was taken home to complete and not submitted to the researcher, however that subject still completed the RIS, informed consent, PARQ and demographics on the day of testing.

Once the researcher had checked that both the informed consent and the PAR-Q were signed and then if no contraindications to exercise were presented, they could continue. The subjects were then asked some personal questions about their health and some more detail surrounding their routine on the day of testing, and this included the food they had eaten before, caffeine/tobacco consumption, exercise on the day, and if anything was different to their normal daily routine on the day of testing. After this, their anthropometric and vascular health measures were taken. Finally, their strength and balance were tested and then the six-minute walk test was completed. Approximately 20 minutes was needed to complete the questionnaires and 40 minutes for the physical measurements and the cardiovascular exam. However, this process did take longer due to the interactive nature of the study and its participants as they were usually keen and available to talk for long periods.

In all retirement villages, the researcher was given their own room and hallway space in which to conduct the assessments. As such, the retirement village's residents did not have to travel outside of their village to participate in the research. In village 1 the researcher had their own fully furnished two-bedroom house to complete the testing, and the walking test was held in the village apartment hallways (indoors, correct length and away from environmental hazards). In village 2 the research was based in a private meeting room, and a portable bed was set up (for the arterial health measurement), the apartment hallway was once again used for the walking test. Finally, in village 3, the researcher was also given the use of a one-bedroom fully furnished apartment to hold the testing, with the cardiovascular walking test completed in the apartment hallway (similar conditions to the first two villages).

3.5 Research inclusion

The inclusion criteria for this research study was as follows:

1. You are living independently in a retirement community in Christchurch

2. You are at least 65 years of age

3. Physically able to participate in a cardiovascular fitness test

4. Prior to participation, you must complete and pass the Physical Activity Readiness Questionnaire which we will send to you. If the participant fails this questionnaire, they will have to get medical clearance prior to enrolment in this study.

Participants would be **excluded** if they did not meet the criteria above.

Those who agreed to participate in the research were given a RIS, which explained the general nature of the research being conducted and what will be required of a participant once involved. As the research project was completed voluntarily, the participants had the option to pull out at any stage of the research until data dissemination (this was stated and listed on the RIS and the advertisement flyer). If the participant chose to continue with the research project, they then completed the informed consent form and were also scheduled with a time for their assessments, and this was either done on the phone with the researcher or via a sign-up sheet at their village.

Once the researcher had scheduled an appointment with the resident, a phone call was made to confirm the appointment (only if the appointment was not originally scheduled by phone), and at this time they were also advised of the following procedures to partake in ahead of the vascular health testing. These are the control conditions for obtaining quality PWA measurements as per the SphygmoCor XCEL (2012), and participants were asked to:

- Abstain from alcohol six hours before testing.

- Abstain from tobacco and caffeine four hours before testing.
- Fast for at least six hours prior to the measurement, however, if this could not be achieved a light meal before the measurement was allowed.

3.6 Questionnaire

The written assessment was in the form of four small questionnaires, put together as one survey, which took approximately 20 minutes to complete. The participant was asked to complete these questionnaires before the appointment time for the assessments. The questionnaire (as seen in Appendix F) consisted of four major sections. The first section involved questions about demographic information such as age, sex, and then further questions surrounding the time they have been in the village and the activities they attend at their village. The demographics section also collected information about the participant's health history, in-particularly noting if they previously have had a stroke and/or heart incident in their health history. The second smaller questionnaire was the YPAS, which was divided into a further two parts. The first section asked participants to recall the time it took them in the last week doing common types of physical activity, which were split into five different categories: work, yard work, caretaking, exercise, and recreation. These categories and questions are particularly important as they give an overview of everyday activities that expend energy (i.e., not only recording physical activity as sessions of exercise and sport as per some surveys). For example, this studies survey included routine and lifestyle aspects such as doing laundry and daily food preparation which is important to include for older adults as it can all be counted and included towards their daily energy expenditure and overall physical activity exertion.

The second section of the YPAS asks participants to recall the activities that they have performed in the past month, this includes questions about vigorous activities, walking, moving, standing, and sitting times every day. This information provides data about the lifestyle that the participants lead (for example, sedentary or active).

The third smaller questionnaire contained the SF-36, which includes questions on older adults' health and an included a section which reflected on a typical day over the last week, it then asks questions which require reflecting on the past four weeks (or monthly recall of activities). In further analysis, the survey groups the questions into eight scale categories which include: physical functioning, role limitations due to physical health, role limitation due to emotional problems, energy and fatigue, emotional wellbeing, social functioning, pain, and general health (Rand Corporation, 2018).

Lastly, the fourth questionnaire contained some questions related to diet (Your Disease Risk Index), which were about everyday nutrition and the portions of different food groups that adults should be consuming. This information was indicative as to what kind of diet and nutritional balance the participants followed. However, it is not be used as an overview of a subject's diet (as it is not a full picture or 24-hour recall diary).

3.7 Vascular Health appraisal

The first stage of the physical assessment entailed some physical measurements (and a cardiovascular exam) which took approximately 20 minutes. First, the participant had their vascular health parameters measured by a non-invasive measurement with the SphygmoCor Xcel, measuring the blood flow velocity (the gold standard in vascular health) and the augmentation index (arterial stiffness) along with brachial cuff systolic and diastolic (blood pressure), central systolic blood pressure, central pulse pressure (aortic PP), central augmented pressure (aortic AP), central augmentation index, SphygmoCor reference age and pulse wave velocity (stiffness of arteries) (SphygmoCor XCEL, 2012).

The subject was first asked to have his/her height and weight measurement taken. They were then asked to lie down flat on a bed, (with no pillow under their head), with palms pointing to ceiling and legs lying straight. To ensure the control conditions and best technique for obtaining quality PWA measurements, the participants were asked to rest comfortably for at least five minutes before the testing began (SphygmoCor XCEL, 2012). During this time, the researcher talked through the upcoming process with the participant and took some additional measurements (non-invasive with a tape measure) on the individual. The first vascular measurement was taken from the brachial cuff (standard blood pressure test), the brachial cuff size was selected according to the patient's limb circumference.

The second test was multi-component and measurements were completed on the quadriceps of the patient with a thigh cuff and at the neck of the participant, on the carotid pulse with a tonometer. All three vascular measurements (arm, thigh, and neck) were taken on the same side of the subject's body. The thigh cuff needed to be placed on the participant's leg as high up as possible (placed outside of clothing when thin, or directly under clothing if clothing was too thick to capture a pulse). Once the thigh cuff was in place, the researcher then located the carotid pulse on the participant. To find the carotid pulse location, participants were asked to lift their chin and rotate their head to the opposite side of the pulse location at a 45-degree angle. Once the strongest pulse location was palpated, a mark with a highlighter pen was placed on the skin. This measurement was sometimes difficult to locate in this population due to excessive skin around that area of the neck, and if necessary, the skin was pushed out flat and tight with fingers to locate the pulse. Length measurements were taken with a SECA 207, a baby measuring rod with larger callipers (also known as an infant stadiometer), were taken from the top of thigh cuff to the carotid mark (highlighted on the skin) and the distance from the top of the femoral cuff to the femoral pulse/hip bone was also measured. These measurements "Carotid to Cuff" and 'Femoral to Cuff" distances were entered in the PWV calculation, along with height and blood pressure before the measurement was completed. The measurement process was discussed with the participant throughout the testing to make sure they felt comfortable and familiar with the processes being undertaken.

To complete the PWV measurements, the researcher placed a tonometer on the carotid artery pulse (after palpated and strongest pulse was found, and then marked with a highlighter). This process is called applanation tonometry and was used to record the carotid artery waveform. This involved practically flattening the carotid artery between the pressure sensor at the top of tonometer and tissue behind the vessel. This accurately recorded the shape of the pulse in the artery- pulse wave calculation. At the same time that the researcher was finding and recording the carotid pulse, the thigh (femoral) cuff was also inflating, which is a similar process to a brachial cuff inflating (for normal blood pressure testing).

To avoid any cultural or moral offence while fitting both the brachial and femoral blood pressure cuffs, participants could assist in fitting the blood pressure cuffs if they chose to do so. The researcher did explain the procedure prior to fitting that the cuff would need to be placed on the upper arm and the upper leg (as high as possible). If at any stage, the participant did appear uncomfortable with the cuff application, the researcher would ask if he/she would like to apply it himself/herself.

3.8 Strength and balance-based testing

Next, the participant was asked to complete two strength tests and one balance test. The participant was asked to complete the repetitions of each exercise within a given time frame. The researcher would first demonstrate the exercise to the participant and then ask them to complete the same task. The strength-based testing exercises included the 30-second chair-sit-to stand (leg strength), and the hand-grip test, additional to this was the four-point balance test.

The 30-second chair sit-to-stand test is used as a test for leg strength and endurance over a 30-second timed period in a chair with no armrests. It is important that the chair being used was seated against a wall or planted object to reduce any unwanted movement. Participants were instructed to stand up from the chair and back down (one repetition) with their arms crossed over their chest. The researcher recorded how many repetitions each participant could complete within the 30-second timeframe. The 30-second chair sit-to-stand results were measured against the CDC's STEADI tool norm scores for each age range for the participant's results. Participants who score below the average score (for their age and gender) indicates a risk for falls (CDC, 2017).

A hand-grip strength test was performed with an Evernew hand dynamometer, and measurements were completed on both participants' hands multiple times. Participants stood for the test and gripped the handle of the dynamometer holding it adjacent to their body during the test with the hand beside the thigh. Participants were instructed to grip as hard as they could without holding in their breath. This measurement was taken at least three times in both hands (alternating each turn) and then recorded in kilograms. The highest of the three values of each hand was recorded and used in the participant's results as a combined score. Results were compared to norms as adapted in The Canadian Physical Activity, Fitness and Lifestyle Appraisal (1996) as cited in ACSM (2005) for the participants. Norms for grip strength range by age groups and gender and are categorised as "above average", "average", "below average", and "poor".

Thirdly, the balance test was measured. This is a multi-component test for static balance, of which there are four stages, which progresses in difficulty. Subjects are asked to perform and hold the progressively difficult positions for 10 seconds to then progress onto the next level (the researcher first demonstrated this stage which was then mirrored by the participant). The progression stages included: Stage 1) parallel stance, 2) semi tandem stance, 3) tandem (heal toes) stance, 4) one legged stance. If a participant could not complete any stage for at least 10 seconds, then they were not able to move onto the next stage and were also graded down (to the last stage that they fully completed). Research indicates that older adults (aged 65 plus) who cannot perform level 3 ACC balance activities (a tandem foot one in front of the other stance) with success are at an increased risk of falling (CDC, 2017).

3.9 Cardiovascular fitness test

The final test for participants was the cardiovascular fitness measurement in the form of the six-minute walk test. This is a sub-maximal measure of aerobic capacity and is especially used to measure functional capability in those with moderately severe impairments (ATS, 2002). The six-minute walk test is used to measure the distance a participant can walk over a total of six minutes on a hard, flat, indoor surface. The goal is for the individual to walk as far as possible in six minutes. The individual could self-pace and rest as needed as they traverse back and forth along a 30-meter-long marked walkway with markers (cones) every three meters and larger cones (for clarity) at the start and end of the distance for participants to turn around at. This test was completed at the participant’s retirement village, in a long, unobstructed hallway that spanned for longer than 30-meters and allowed enough room for turning (width ways). The researcher recorded how many lengths the participant completed throughout the testing duration. The participants were also asked to wear a Polar heart rate monitor during testing from which their maximum and average heart rate over the test were recorded. The participants were also asked to complete the Borg Rate of Perceived Exertion (RPE), both before and after the completion of the six-minute walking test. The RPE scale ranged from 0 to 10, with 0 equating to (nothing at all) to 10 (very, very heavy) exertion.

This form of testing followed the procedures and guidelines set forth by the American Thoracic Society (2002). It was essential during the test to not hold a conversation with the participant, first to save their breath, and to ensure that the verbal language or body language of the researcher was not used to dictate the participant’s natural speed during the test. Therefore, the same communication procedure was followed for this testing. After explaining the test and signalling the start of the assessment, the researcher would then only communicate (in an even tone) with the participant to advise every minute that had passed during the test and then only when there was 30-seconds remaining. Further communication during the test was only used if the researcher deemed it was necessary to check on the participant during the six minutes.

3.10 Ethics

Ethical procedures were followed for this research. An application to the Lincoln University Human Ethics Committee was approved, reference number 2017-34. It was ensured that only participants who were able to give informed consent were included in this research. To ensure the anonymity and confidentially of the participants, the following procedures have taken place, pseudonyms and code names were used in any written or oral project, and no individual identification will be presented in public. Participants, furthermore, had the right to withdraw from the study at any time without reason.

Due to the slightly physically active nature of this research, however, there were some risks involved. The most common being soft-tissue injuries such as sprains and strains. Although minimal, in order to mitigate the risks associated with physical activity measurements at the time, the study used the existing indoor spaces at their retirement village(s), in which the participants are already accustomed to using and would eliminate the risk of tripping hazards and harsh environmental exposure. This also controlled for the risk of injury and stress, as the space used was a walkway indoors that the subjects were accustomed to walking in. However, if any physical or psychological discomfort arouse, the participants did have the right to discontinue at any time (and were reminded of this throughout their participation in the research). In this instance, the researcher would guide the participant to the experts and staff available at their relevant retirement health centre. The researcher also had first aid certification, and if needed, there was a protocol in place that the participants would be referred to the facility health care located on the retirement premises at the time of testing.

3.11 Analysis

Once collected, the multiple questionnaires' data and cardiovascular testing results were entered in their raw format into an Excel spreadsheet/database, which was safeguarded with a password which ensured anonymity and confidentiality. Codes rather than names and other identifiers were the method of security employed. The data were populated in Excel, then processed and analysed in SPSS using Pearson correlations and hierarchical multiple regression. A P-value of $p<0.05$ was selected as the statistical significance for these tests. This is a commonly used statistically significant cut-off point for this type of research.

All participants had the option of receiving their cardiovascular fitness score and their measured cardiovascular disease (CVD) risk parameters for their participation in the research project. At all three retirement villages, there were multiple results presentations where individuals could come to collect their results. Additionally, a presentation on how to read and interpret their own results was discussed with the audience. This time was also used as an opportunity for participants to ask any further questions.

3.11.1 Survey Analysis

The demographics collected were numerically coded as raw data, body mass index (BMI) was also calculated by dividing the subject’s weight in kilograms by their height in metres squared. All data were entered, run, and analysed in SPSS for descriptive statistics.

The YPAS was analysed as its raw data in two parts. First, in part 1, the activity minutes were multiplied by an intensity code and then summed for all the activities (work, yard work, caretaking, exercise, and recreation). Which then created an energy expenditure summary index, summarised as kilocalories per week (kcal/week). However, for this research, there was a further necessity to assess the association of MET-mins in relation to other health indicators and not Kcals. Therefore, converting Kcals/week into MET minutes/week (another form of energy expenditure) was completed by recoding the intensity codes that were assigned to the particular activity in each section of the YPAS and instead the matching title conversion intensity codes were inserted from the Compendium of Physical Activities (2011) (Ainsworth et al., 2011a; 2011b). The Compendium was first developed in the 1980’s to standardised MET intensities to use in epidemiology surveys and physical activities questionnaires, this compendium, used to standardise METs have been updated in 1993, 2000 and 2011 (Ainsworth et al., 2000; 2011a; 2011b), the 2011 version was used to recode the YPAS intensity codes. The activities listed in the survey were recoded with the METs codes as per the Compendium 2011 version, and then continued to be multiplied and calculated by the same procedure. First, the activities in each section were multiplied by the minutes that they were completed over the week (as indicated by the participant in the survey) to calculate the MET minutes per week for each of the five activity sections. Additionally, the Compendium was also helpful to code the activities that were listed under the title 'other' in each section of the survey. In these spaces, participants could write any additional activities they completed, which had not been listed in the survey, but they did not have an intensity code identified in YPAS. Before the recoding occurred and converting the activity codes to METs, the survey was unable to identify any items under "other". By using the compendium to code the activities, those answers were then able to be officially individually coded and multiplied in their section. This meant that the correct code intensity code, and therefore the MET-mins could be calculated for any additional activity that was completed by the participant and a full picture of the MET minutes/week incorporating their full lifestyle could be calculated. The energy expenditure summary index, now summarised as MET-mins, were analysed, and processed in SPSS as one of the dependent variables of the study (MET-mins).

In part two of the YPAS, the activities performed (as self-reported) in the last month are then calculated by multiplying the frequencies score (listed/selected by participant) by the duration score (listed/selected by participant) for each of the five specific activities (vigorous, leisurely walking, moving, standing, or sitting) and then multiplied by the weighting factor (listed for each) and then adjusted to the intensity of the activities dimension to complete the score. The final index score is the sum of the five indices.

The SF-36 was analysed in a two-step process. First, the answers were coded to their predetermined numeric values, given in Table 1 of the Rand Corporation (2018). In step two the items of the same scale are added together (and then averaged for the number of items in each scale), which creates eight scale scores: physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional wellbeing, social functioning, pain, and general health. These averaged scale scores are then analysed and processed in SPSS as independent variables for "Quality of Life" measurements.

The nutrition questionnaire derived the tool called Your Disease Risk Index. Within this questionnaire, of the ten questions listed, nine were either yes/no answers, and one question required a numerical answer. These responses were then coded to a point system (either scoring a point or not), depending on the answer. Ideally, the higher the score, the better the diet, and vice versa, the lower the score, the poorer the diet, the highest number that could be scored within this questionnaire was a ten. However, during analysis, the questionnaire was reduced to nine questions, as question eight was removed: "do you eat oil-based salad dressing or use liquid vegetable oil for cooking on most days?" as it was deemed not to be relevant to the data set and was more applicable to the American diet. The rest of the questionnaire was marked the same as suggested above. However, the highest score that could now be calculated was nine. The total score from the nutrition questionnaire was processed in SPSS as an independent variable for diet.

3.12.2 Physiological Analysis

All physiological measurements were recorded on a data sheet in their raw format and then entered onto an excel spreadsheet, where they were transferred to SPSS and then run as descriptive statistics, Pearson correlations and in a hierarchical multiple regression. A P-value was set at $p<0.05$ to determine the statistical significance for these tests. This is a commonly used statistically significant cut-off point for this type of research.

In addition, multiple hierarchal regressions were generated to predict PWV and METs based on a range of independent variables. Note that, within the multiple hierarchical regression N=80 due to some participants missing scores on one or more variables and multiple regression only analyses the participants whom did have complete data sets (listwise exclusion) for all the variables meaning that there is a smaller sample size to analyses in the regression.

Given the nature of health parameters, there were potential confounding variables which needed to be controlled for prior to analysis of the two dependent variables of interest (PWV and METs) along with the eight predictor variables. The confounding variables were identified at the start of analysis from both the literature and the statistical significance that was seen in the initial intercorrelations. Age, heart incident, stroke and diet were all identified as potential covariates that would influence both METs and PWV and were therefore added as covariates in the multiple hierarchical regression model. Assumptions for multiple hierarchical regressions were checked including multicollinearity (below 0.7), tolerance (scores none below 0.1), VIF (none above 10), and linearity. The Mahalanobis distance was also examined and met assumptions with no indicated multivariate outliers. Residual and scatter plots indicated the assumptions of normality, linearity and, homoscedasticity were all satisfied. Hierarchical multiple regressions were run, first, to control for covariates and then to analyse the predictive power of eight independent (predictor) variables separately for PWV and then for METs.

Chapter 4

Results

4.1 Introduction

Of the 95 subjects, 28 males, and 67 females were retained in the analysis. Subjects were older adults aged 78.86 ± 6.47 years, who had lived in their respective villages 1.87 ± 1.36 years, their height was 162.77 ± 8.63 centimetres, and weight 70.06 ± 12.58 kilograms, equating to a BMI of 26.44 ± 4.22 (M, SD). The full descriptive statistics for participants that were included in the total data analysis are recorded in Tables 1, 2, 3 and 4.

The gender and health characteristics of the participants are included in Table 5 and 6 respectively, low percentages rates of the previous heart (26.4%) and stroke (7.4%) incidents, as well as a low percentage of smokers (2.1%) were reported in the study population.

Table 1 Descriptive characteristics of total sample

Variables	n	*M*	*SD*
Age (years)	95	78.86	6.47
Height (cm)	93	162.77	8.63
Weight (kg)	93	70.06	12.58
Body mass index (kg/m^2)	93	26.44	4.22
Years lived in village (years)	93	1.87	1.36

Table 2 Vascular health variables of total sample

Variables	n	*M*	*SD*
Pulse wave velocity (PWV) (m/s)	83	11.86	2.40
Average heart rate (bpm)	91	96.09	17.15
Brachial systolic blood pressure (mmHg)	92	134.65	15.24

Table 3 Strength, Balance and Cardiovascular variables of total sample

Strength and balance variables	n	*M*	*SD*
Leg strength (# of repetitions)	91	11.67	3.52
Grip strength (kg)	93	52.09	16.33
Balance (1-4)	93	3.57	0.63
Cardiovascular variable			
Aerobic capacity (metres)	93	444.72	99.54

Table 4 Questionnaire Health and quality of life variables of total sample

Health-related questionnaire variables	n	*M*	*SD*
MET-minutes (minutes per week)	94	4557.64	2836.22
Diet (scale 1-8)	94	5.56	1.60
Quality of life variables			
Physical functioning (10 measures)	94	74.47	24.81
Role limitations due to physical health (4)	94	307.45	130.54
Role limitations due to emotional problems (4)	94	241.06	95.20
Energy (4 measures)	94	294.79	50.13
Emotional well-being (5 measures)	94	423.40	54.84
Social functioning (2 measures)	94	175.80	33.37
Pain (2 measures)	94	158.30	45.25
General health (5 measures)	94	388.51	65.57

Table 5 Gender characteristics of participants

Variable	N	%
Male	28	29.5
Female	67	70.5
Total	95	100

Table 6 Health characteristics of participants

Conditions	N	YES	YES %	NO	NO %
Heart incident	94	26	27.4	68	71.6
Stroke	95	7	7.4	88	92.6
Smoker	94	2	2.1	92	96.8
Heart/blood pressure medications	94	56	52.6	38	40.4

4.2 Hierarchical multiple regression with PWV as the dependent variable

4.2.1 PWV as dependent variable Model 1

Hierarchical multiple regressions were conducted to investigate the best predictors of PWV using two models. The first model contained four control variables (covariates) and the second model contained those covariates plus eight additional predictor variables. The means, standard deviations, and correlations can be found in Table 7. The covariates in Model 1 used to predict PWV included age, heart incident, stroke and diet, $F(4,75) = 11.21$, $p < .001$.

Table 7 shows that all four covariate variables were correlated to PWV. All effect size categories are taken from Cohen (1988). The strongest positive correlation, which would be considered a large effect size, was between PWV and age (r=.50, p<.01), whereby older participants correlated with a higher PWV. PWV and previously having a stroke were also positively correlated (r=.33, p <.05) along with previously having a heart incident (r=.31, p <.05), both classified as a medium effect size. PWV was further negatively correlated with a healthy diet (*r*=-0.23, $p < .05$) whereby a high PWV score correlated with a low score for diet (poor diet) a small to medium effect size.

4.2.2 PWV as dependent variable Model 2

Hierarchical multiple regressions were conducted to investigate the predictors of PWV. The means, standard deviations, and correlations are shown in Table 7. When the combination of variables to predict PWV included age, heart incident, stroke, diet, MET-mins, BMI, leg strength, grip strength, balance, aerobic capacity, average heart rate and brachial systolic blood pressure, $F(12,67) = 5.94$, $p<.001$.

Table 7 shows that an additional four predictor variables were also correlated to PWV, including brachial systolic blood pressure, MET-mins, leg strength and aerobic capacity. The strongest positive correlation, which would be considered a large effect size, was between PWV and brachial systolic blood pressure (r=.50, p<.001), whereby higher PWV scores also were associated with higher brachial blood pressure. There was a negative correlation between PWV and MET-mins (r=-.31, p<.05), a medium effect size, with a higher PWV score, correlated with a lower score of total MET-mins for participants (e.g., lower amount of exercise). Leg strength was also correlated negatively with PWV (r=-.23, p<.05) a small to medium effect size, where the higher the PWV value correlated to the lower number sit to stands that were completed. Aerobic capacity was also negatively correlated with PWV (r=-.19, p<.05), whilst the higher the PWV, the less walking distance that was completed in the six-minute walk test, a small to medium effect size. Table 8 shows the means, standard deviations for all variables correlated (N=80).

Table 7 Intercorrelations for PWV with covariates and predictor variables (N=80)

Variable	PWV	Age	HI	Stroke	Diet	METm	BMI	Leg S	Grip	Balance	Aerobic	AHR	BSBP
PWV	-												
Age	.50**	-											
HI	.31*	.25*	-										
Stroke	.33*	.21*	-.05	-									
Diet	-.23*	-.30**	.18	-.13	-								
METm	-.31*	-.46***	-.12	-.27**	.15	-							
BMI	-.08	-.17	0	-.08	-.02	-.01	-						
Leg S	-.23*	-.08	.04	-.11	.17	.22*	-.14	-					
Grip	.04	-.12	.27	-.03	.05	.16	-.01	.30***	-				
Balance	-.21	-.37***	.00**	-.18	.12	.32**	-.21*	.38***	.24*	-			
Aerobic	-.19*	-.35**	.08	-.16	.13	.24*	-.31**	.48***	.44***	.41***	-		
AHR	-.11	-.21*	-.02	.03	.21*	.15	-.07	.34**	.19*	.04	.52***	-	
BSBP	.50***	.27**	.04	.20*	-.17	-.22*	-.01	-.23*	-.06	.03	-.22*	-.25*	-

**p*<.05; ***p*<.01; ****p*<.001

PWV = Pulse wave velocity (m/s), Age (years) HI = Heart incident (previously recorded), Stroke (previously recorded), METm= MET minutes (minutes per week), BMI= body mass index (kg/m^2), Leg S = Leg strength (# of repetition), Grip= grip strength (kg), Balance (1-4), Aerobic = aerobic capacity (metres), AHR= Average Heart Rate (bpm), BSBP = Brachial Systolic Blood Pressure (mmHg).

Table 8 Means, standard deviations for all variables (N=80)

Variable	*M*	*SD*
Pulse Wave Velocity (m/s)	11.76	2.36
MET-mins (per week)	4810.33	2931.19
Age (years)	78.13	6.4
Heart incident (previous)	.29	.48
Stroke (previous)	.06	.24
Diet (1-9)	5.58	1.57
BMI (kg/m^2)	26.22	4.18
Leg strength (# of reps)	11.94	3.57
Grip strength (kg)	52.16	15.8
Balance (1-4)	3.61	.61
Aerobic capacity (metres)	455.68	98.21
Average heart rate (bpm)	96.25	17.21
Brachial Systolic BP (mmHg)	133.43	14.87*

4.3 Multiple hierarchical regression PWV Model 1 and 2 analysis

The beta coefficients are presented in Table 9, note that age, heart incident and stroke significantly predicted PWV when all four control variables (covariates) were entered into Model 1. The adjusted R-Square value was .341, meaning 34.1% of the variance in PWV was explained by the four covariates in Model 1 $F(4,75) = 11.21$, $p < .001$. Model 1 is a significant predictor of PWV at the $p < .001$ level when including the four covariates.

When the combination of four covariates and eight predictor variables in Model 2 were used to predict PWV, $F(12,67) = 5.94$, $p < .001$. The adjusted R-Square value was .429, and this indicates that 43% of the variance in PWV was explained by Model 2 with all predictor variables controlled for. Model 2 is a significant predictor of PWV at the *p*<.001 level after controlling for the four covariates and then adding the eight health-related predictor variables. Age and heart incident were still significant contributors to Model 2, and in addition, brachial systolic blood pressure was a significant predictor of PWV in Model 2.

The R-Square change between Model 1 and Model 2 was .141, which indicates that 14.1% of additional variance in the outcome comes from the eight additional predictor variables beyond what the covariates have already accounted for. The R-Square change value was significant at the *p*<.05 level. Model 2 had a significant *F* change of 0.022, which means the addition of eight predictor variables had significantly predicted PWV. Although, the standardised beta weights in Table 9 shows that the variance from came from one predictor variable brachial systolic blood pressure (BSBP) in Model 2. Table 8, above, shows the means, standard deviations for all variables correlated (N=80).

Table 9 Hierarchical multiple regression analysis summary for Models 1 and 2 for PWV (N=80)

	Model 1			Model 2		
Variables	*B*	*SEB*	β	*B*	*SEB*	β
Age	.12	.04	.34***	.10	.05	.27*
Heart incident	1.32	.48	.27**	1.20	.48	.24**
Stroke	2.48	.91	.26**	1.69	.90	.17
Diet	-.22	.15	-.15	-.16	.15	-.11
MET- minutes				.00	.00	.02
BMI				-.02	.06	-.04
Leg strength				-.10	.07	-.15
Grip strength				.01	.02	.08
Balance				-.23	.43	-.06
Aerobic capacity				.00	.00	.00
Avg HR				.01	.01	.09
BSBP				.06	.02	.36***
(Constant)	2.76	3.3		-2.62	5.86	

Note. Model 1: R^2 =.37 F(4,75) = 11.2,p<.001.
Model 2: R^2 =.52; F(12,67) = 5.94,p<.001.
*p<.05; **p<.01; ***p<.001
BMI= Body Mass Index, Ave HR= Average Heart Rate, BSBP = Brachial Systolic Blood Pressure.

4.4 Hierarchical multiple regression with MET minutes as the dependent variable

4.4.1 MET minutes as dependent variable Model 1

Hierarchical multiple regressions were conducted to investigate the best predictors of MET-mins using two models. The first model contained four covariates and the second model contained those covariates plus eight predictor variables. The means, standard deviations, and correlations are displayed in Table 10. When the combination of covariates in Model 1 were used to predict MET-mins included age, heart incident, stroke, diet, $F(4,75) = 5.94$, $p<.001$.

Table 10 shows that three out of the four covariates were all negatively associated with MET-mins. The strongest negative correlation, which would be considered a large effect size, was between MET-mins and age ($r=-.46$, $p<.001$), in which older participants were associated with lower reported MET-mins. MET-mins and PWV were also negatively correlated ($r=-.31$ p<.01), whereby higher MET-mins were correlated to lower PWV, a medium effect size. MET-mins and previously reporting a stroke incident were negatively correlated ($r=-.27$, $p<0.01$), where higher MET-mins correlated with not previously having had stroke, a small to medium size effect.

4.4.2 MET minutes as the dependent variable Model 2

Hierarchical multiple regressions were conducted to investigate the predictors of MET-mins. The means, standard deviations, and correlations are presented in Table 10. When the combination of variables to predict MET-mins in Model 2 included age, heart incident, stroke, diet, PWV, BMI, leg strength, grip strength, balance, aerobic capacity, average heart rate and brachial systolic blood pressure, $F(12,67) = 2.36$, $p = .014$.

Table 10 shows that an additional four predictor variables were also correlated with MET-mins and all showed a moderately strong relationship. The strongest positive correlation was between MET-mins and balance ($r=-0.32$, $p<.05$), a medium effect size, where the higher the MET-mins accumulated is associated with higher balance scores (e.g., better balance). The strongest negative correlation was between MET-mins and PWV ($r=-.31$, $p<.01$), another medium effect size, whereby higher MET-mins correlated to lower PWV. Higher MET-mins is also positively correlated with aerobic capacity ($r=0.24$,

p<.05) and negatively correlated with lower brachial systolic blood pressure (r=-.22, p<.01) both of which are small to medium effect size.

Table 10 Intercorrelations for MET-minutes with covariates and predictor variables

Variables	METm	Age	HI	Stroke	Diet	PWV	BMI	Leg S	Grip	Balance	Aerobic	AHR	BSBP
METm	-												
Age	-.46***	-											
HI	-.12	.25*	-										
Stroke	-.27**	.21*	-.05	-									
Diet	.15	-.30**	.18	-.13	-								
PWV	-.31**	.50***	.31**	.33**	-.23*	-							
BMI	-.01	-.17	0	-.08	-.02	-.08	-						
Leg S	.22*	-.08	.04	-.11	.17	-.23**	-.14	-					
Grip	.16	-.12	.27**	-.03	.05	.04	-.01	.30**	-				
Balance	.32*	-.37***	0	-.18	.12	-.21*	-.21**	.38***	.24*	-			
Aerobic	.24*	-.35**	.08	-.16	.13	-.19*	-.31*	.48***	.44***	.41***	-		
AHR	.15	-.21*	-.02	.03	.21*	-.11	-.07	.34**	.19*	.04	.52***	-	
BSBP	-.22*	.27**	.04	.20*	-.17	.50***	-.01	-.23*	-.06	.03	-.22*	-.25**	-

*p<.05; **p<.01; ***p<.001

METm= MET minutes (minutes per week), Age (years) HI = Heart incident (previously recorded), Stroke (previously recorded), PWV = Pulse wave velocity (m/s), BMI= body mass index (kg/m^2), Leg S = Leg strength (# of repetition), Grip= grip strength (kg), Balance (1-4), Aerobic = aerobic capacity (metres), AHR= Average Heart Rate (bpm), BSBP = Brachial Systolic Blood Pressure (mmHg).

4.5 Multiple hierarchical regression MET minutes Model 1 and 2 analysis

The beta coefficients are presented in Table 11, note that age significantly predicted MET-mins when all four control variables (covariates) were entered into Model 1. The adjusted R-Square value was .20, indicating that 20% of the variance in MET-mins was explained by the four covariates in Model 1: $F(4,75) = 5.94$, p<.001. Model 1 is a significant predictor of MET-mins at the p<.001 level when the four covariates were included.

When the combination of four covariates and eight predictor variables in Model 2 were used to predict MET-mins, $F(12,67) = 2.36$, p =.014. The adjusted R-Square value was .171, indicating that 17.1% of the variance in MET-mins was explained by Model 2, with all predictor variables controlled for. Model 2 is a significant predictor of MET-mins at the $p<.05$ level after controlling for the four covariates and adding the eight health-related predictor variables. Age was still a significant contributor to MET-mins in Model 2. The R-Square change between Model 1 and Model 2 was not significant at any level and therefore was not a statistically significant contribution.

Table 11 Hierarchical multiple regression analysis summary for Models 1 and 2 for MET minutes (N=80)

	Model 1			*Model 2*		
Variables	*B*	*SEB*	β	*B*	*SEB*	β
Age	-186.08	52.05	-0.41**	-172.97	69.07	-0.38*
Heart incident	-212.58	658.53	-0.03	-364.32	755.03	-0.06
Stroke	-2145.59	1247.81	-0.18	-2060.72	1360.86	-0.17
Diet	32.59	204.26	0.02	-24.88	219.48	-0.01
PWV				28.2	182.83	0.02
BMI				-54.08	84.54	-0.08
Leg strength				90.6	108.24	0.11
Grip strength				19.66	22.69	0.11
Balance				653.57	643.61	0.14
Aerobic capacity				-4.18	4.95	-0.14
Avg HR				10.58	22.46	0.06
BSBP				-16.88	24.94	-0.09
(Constant)	19361.51	4514.01		18454.51	8485.48	

Note. Model 1: $R^2=.24$; $F(4,75) = 5.94, p<.001$
Model 2: $R^2=.30$; $F(12,67) = 2.36, p=.014$.
$^*p<.05$; $^{**}p<.01$; $^{***}p<.001$
PWV= pulse wave velocity, BMI = body mass index, Ave HR= average heart rate, BSBP = brachial systolic blood pressure.

4.6 Pearson correlation MET minutes and PWV with QOL predictor variables

The QOL variables were analysed Pearson correlation looking at the simplified case, with eight predictor variables. Due to having a sample size of 95 we allowed one variable per 10 participants and no corrections were used. Table 12 shows that four out of the eight predictor quality of life (QOL) variables are strongly and positively correlated to MET-mins. The strongest positive correlation is between MET-mins and physical functioning ($r=.34$, $p<.0001$) a medium effect size, whereby a high level of MET-mins correlated with a high score of physical functioning (better). There was also a positive correlation between MET-mins and general health ($r=.29$, $p<.005$), a small to medium effect, whereby a high MET-mins score is correlated with a high general health score (better). MET-mins were also positively correlated to role limitations due to emotional problems ($r=.28$, $p<.006$) a small to medium effect size, a high MET-mins score was correlated with a higher score of 'not' being limited due to emotional problems. Finally, MET-mins and role limitations due to physical health were positively correlated (*r*=.24, *p*<.022), in which high MET-mins were correlated with a high score which indicates 'not' being limited due to physical health (good), another small to medium effect size.

Table 12 further shows that three out of the eight predictor QOL variables are strongly negatively correlated with PWV. The strongest negative correlation was between PWV and limitations due to physical health, a small to medium effect, (*r*=-.27, *p*<.015). There was a negative correlation between PWV and role limitations due to emotional problems (*r*=-.24, *p*<.027) a small to medium effect, where a high PWV score, was correlated to lower role limitations due to emotional score. Furthermore, there was a negative correlation between PWV and physical functioning (*r*=-.22, *p*<.05), whereby a higher PWV correlated with lower physical functioning (less able) a small to medium effect size.

Table 12 Pearson correlations of MET minutes and PWV with QOL predictor variables

	MET-mins			PWV		
Variables	*N*	*r*	*P*	*N*	*r*	*P*
Physical functioning	94	.34**	<.001	82	-.22*	.050
Role limitations due to physical functioning	94	.24*	.022	82	-.27*	.015
Role limitations due to emotional problems	94	.28**	.006	82	-.24*	.027
Energy/fatigue	94	.16	.134	82	-.11	.339
Emotional well-being	94	.05	.602	82	.04	.740
Social functioning	94	.09	.399	82	-.12	.266
Pain	94	.12	.259	82	.11	.304
General Health	94	.29**	.005	82	.05	.683

**p*<.05; ***p*<.01; ****p*<.001
MET-mins = MET minutes, PWV = Pulse Wave Velocity.

4.7 Physical Activity Measurements

Table 13 demonstrates that close to 99% of the subjects in this population meet the recommended weekly MET minutes as per the Physical Activity Guidelines Advisory Committee Scientific Report (2018).

Thus, showing evidence that this sample was one of a relatively high level of physical activity and potential fitness within this study. Table 14 further shows that over 92% of subjects within this population could complete the tandem stance in the four-stage balance test.

Table 13 Participants and MET-minute Guidelines

MET minutes per week	N	%	Guidelines
0-499	1	1.06	Do not meet
500-1000	3	3.19	Meets guidelines
1001+	90	95.74	Exceeding Guidelines
Total	94	-	
Missing	1	-	

Table 14 Participants Balance testing results

Balance level completed	N	%
2	7	7.53
3	26	27.96
4	60	64.52
Total	93	-
Missing	2	-

Chapter 5

Discussion

The rationale for undertaking this research was to inform existing physical activity guidelines for older adults and to understand the relationship between physical activity parameters and vascular health.

To the researcher's knowledge, this was the first study that has objectively measured arterial health of older adults living independently in retirement villages along with other measures of health and physical activity. A uniqueness of this study is that it has used PWV, a gold standard measure in vascular health tests of arterial stiffness, to measure the stiffness of arteries in older adults. This study is also unique in that it addresses the less-researched population of residents living in a retirement home or village setting instead of community-dwelling residents and those living in residential care facilities. There is more literature on residential care which services residents with various physical limitations. For example, the MOH (2006) found that people who are living in residential care are likely to be more sedentary than those living without support care in the community. Perhaps those in residential care are more likely to have physical limitations than those still physically able to live in the community. This could impact the physical activity levels that are seen within different housing situations among New Zealand's older adults.

This thesis also aimed to expand on Lacey's et al. (2015) work on the accumulation of lifestyle physical activities by using the YPAS to help critically analyse lifestyle physical activity in older adults. Maintaining lifestyle physical activity is especially important in older adulthood to buffer the negative influences on health that come with the natural ageing process such as a decline of general health and bodily functions (ACSM, 2014). This study measured overall lifestyle physical activity and energy expenditure throughout the week via total MET-mins and was successful in measuring the overall activity levels of the participants. However, due to the small sample size, it was impossible to drill down into the various age groups and their activity levels within this cohort. It would have been ideal to analyse subgroups based on age to determine if there are thresholds between MET- mins and other health variables within this population and to determine the level of physical activity that correlates to the best health outcomes. This could indicate what level of physical activity correlates to the best vascular and other health outcomes and establish if there is a 'threshold' or 'plateau' for physical activity levels in the ageing population. Currently, the WHO's (2011) physical activity recommendations are the same for adults (<65 years) as well as older adults (>65 years). This study attempted to investigate how various levels of MET-mins might influence older adults differently with regard to various health parameters. Perhaps, for example, high levels of exercise (beyond the 150 minutes weekly) is harmful to the overall health of older adults. We aimed to make these comparisons in this study but lacked the sample size to create the sufficiently sized age groupings. Future studies might include at least 30 people in each age grouping for comparison.

5.1 Research Question Results

There were two predominant research questions explored in this study which aimed to determine the strength of the association between MET-mins and PWV with various health parameters, a) vascular health, b) strength, c) balance and d) quality of life.

Results from this study suggested that there were some associations between MET minutes and several health parameters. First, was a negative correlation between PWV and MET-mins (r=-.31, p<.05). The strength of the association between MET minutes and PWV included two measures. MET-mins and PWV were moderately negatively correlated (r=-.31 p<.01) to one another, and they were also moderately negatively correlated with brachial systolic blood pressure (r=-.22, p<.01). There was a moderately positive correlation between leg strength and (r=-.22, p<.05) a moderate positive correlation between MET-mins and balance (r=0.32, p<.05). Furthermore, there were four quality of life variables which were strongly and positively correlated to MET-mins. The strongest positive correlation was between MET-mins and physical functioning (r=.34, p<.001), followed by general health (r=.29, p<.005) role limitations due to emotional problems (r=.28, p<.006) and lastly limitations due to physical health were positively correlated (r=.24, p<.022). All of these were small to medium effect sizes.

The strength of the association between PWV and health measures varied in strength. Aerobic capacity was also negatively correlated with PWV (r=-.19, p<.05). Two measures were used to assess the strength of the association between PWV and strength, leg strength correlated negatively (r=-.23, p<.05) and three quality of life variables were strongly negatively correlated with PWV. The strongest negative correlation was between PWV and role limitations due to physical health (r=-.27, p<.015), then role limitations due to emotional health (*r*=-.24, *p*<.027) and physical functioning (*r*=-.22, *p*<.05). All of which ranged from small to medium effect size.

Overall, the objectives from this research project were to determine the relationship between MET minutes and PWV with a) vascular health, b) muscular strength, c) balance and d) quality of life which has been completed and achieved to a certain degree among older adults living independently in retirement villages. However, to make statements about their effects on the wider population would require a larger sample size to account for a wider spread of physical activity and health parameter scores.

5.2 Major Findings

5.2.1 Age

One of the major findings of this study was the association of age with various health measures. The average age of participants in this study was 78.95 for females and 81.07 for males. In total, 5.7% of the participants were aged 90 or older (N=6), with the oldest participant aged 91 years old. In addition, there were 17 men and 13 women in the study who surpassed New Zealand's average life expectancy for males (80.2 years) and females (83.6 years) (Stats NZ, 2019a). This could suggest that a healthier cross section sample of older participants participated in this study and many of the study cohort are living longer than to would normally be expected in the population of New Zealand's older adults. However, their longevity could also be due to a range of factors: their high physical activity levels could be contributing to this along with other lifestyle factors (e.g., genetics, diet, wealth etc.).

Another significant outcome of this study was discovering that age was related to both PWV and MET-mins and was found to be the strongest positive correlation with both PWV and MET-mins. Age showed its strong correlation as was a significant predictor of the outcomes in both hierarchical regression models analysis of PWV and MET-mins.

Age is known to be a major determinant of poor PWA and PWV measures (Sattelmair et al., 2009). PWV values are expected to increase with age as the arteries stiffen due to the natural process of ageing (Sattelmair et al., 2009). The strongest correlation within the two dependent factors was between PWV and age (*r*=.50, *p*<.01), a strong effect size. This suggests that PWV is correlated with age, a similar finding to other studies such as Boutouyrie & Vermeersch (2010), where PWV increased with both age and blood pressure values. Another study involving younger participants aged 31 ± 12 years of age (M, SD) reported that age was still a major risk factor for PWV and correlated significantly (Doupis et al., 2016). In this research, the findings suggest that the older the participants, the higher the PWV score and vice versa. As a result of this finding and previous research suggesting age to be a determinant of both vascular health and physical activity, the researcher decided to control for age as a covariate in this study. Further, age highly predicted PWV when all four covariates including age, heart incident, stroke and diet were entered into Model 1, where 34.1% of the variance in PWV was explained by the model, of which age (along with heart incident and stroke) were significant predictors of PWV. Age was still a significant contributor to Model 2. These findings are consistent with the literature suggesting the link between physical activity levels, age-related blood pressure and arterial ageing. Furthermore, the natural process of progressive stiffening of the arteries has been known to occur after the age of 40 (Shibata et al., 2018).

The second strongest correlation within the two dependent variables was between MET-mins and age (r=-.46, p<.001), a medium effect size. Indicating that older age was associated with lower reported METs-mins and vice versa, that younger ages were associated with higher MET-mins. Previous studies have indicated that physical activity levels reduce in older adulthood due to sedentary lifestyles, which are linked to an increase in central arterial stiffness in older adults (Shibata et al., 2018). Age also highly predicted MET-mins when all four control variables were used in Model 1, and 20% of the variance in MET-mins was explained by Model 1 which included age, heart incident, stroke, and diet and further age was still a significant contributor to MET-mins in Model 2.

In addition, age had strong correlations with eight out of the twelve variables which were analysed together, including PWV and MET-mins (as listed above). Furthermore, age had the strongest correlation with the following measures, which were also identified as covariates: diet (r=.30, p<.01), heart incident (r=.25, p<.05) and stroke (r=.21, p<.05), all of which are small to medium effect size.). Age further correlated with other independent variables including balance (r=.37, p<.005), aerobic capacity (r=.35, p<.01), brachial systolic blood pressure (r=.27, p<.05) and average heart rate (r=.21, p<.05) these also ranged from small to medium effect sizes.).

Future studies should consider controlling for age, while also having a large enough sample size to provide power in analysing age along with other variables. This would allow for more statistical power to measure the correlation between other variables affecting the association between PWV and MET-mins without age being such an influence.

5.2.2 Controlling for Covariates

Covariates or control variables, including age (as mentioned above) stroke, heart incident and diet were identified at the beginning of the analysis, with support from the literature suggesting those factors influenced PWV and MET-mins. PWV and having had a stroke were moderately positively correlated (r=.33, p <.05). Research by Laurent et al. (2003) indicated that PWV was a significant predictor of stroke death for adults aged 51 ± 13 years (M, SD). PWV significantly predicted the occurrence of stroke death in the whole population. Similarly, having had a heart incident (r=.31, p <.05) was also moderately positively correlated to PWV. Overall, higher PWV scores were associated with an increased risk of having had a stroke or heart incident. This suggests that stroke and heart incidents usually are associated with increased pressure on the vascular system, which directly involves the pulse waves. However, there is also the possibility that just over half of the study participants (52.6%) who were taking prescribed blood pressure or heart medications might have what appear to be 'healthier-looking' arteries and lowered blood pressure compared to what might be indicated without pharmaceutical intervention. Due to this, the researcher suspects that arterial stiffness could be worse if they were not on those medication as blood pressure is a factor affecting increased arterial stiffness.

PWV was further identified to be negatively correlated with a healthy diet (r=-0.23, p <.05) whereas a higher PWV score was correlated with poor diet, a small effect size.). Literature would suggest that high PWV scores can be connected to a poor diet, dietary salt intake in with advancing age has been linked to vascular stiffening (Shirwany & Zou, 2010) and the (WHO, 2012; MOH, 2020) recommends to lower sodium intake. Thus, aiming to lower blood pressure and reduce the risk of stroke and cardiovascular disease. Coronary heart disease includes the development of atherosclerosis, which is the build-up of fatty plaque on the arterial walls, causing progressive narrowing of the arteries (Kim & Kim, 2019) one of the causes can be linked to a poor diet, which in time elevates blood pressure and PWV (Heart Foundation, 2020b; ACSM 2010). Poor diet items can include large consumption of sodium, saturated fats, cholesterol, added sugars and can contribute to obesity, cardiovascular disease, along with a host of other comorbidities (WHO, 2012; MOH, 2020). The diet scale ranged from 1-9, and the average diet score was 5.56 ± 1.6 (M, SD), indicating that the overall average diet in this population was above the halfway mark. Healthy eating has further been linked to promoting healthy arteries and can reduce risks of cardiovascular diseases (Nutrition Foundation, 2018; Heart Foundation, 2020).

After controlling for previous stroke incident, the results showed that those who previously reported a stroke incident in their health history showed a negative correlation with MET-mins (r=-.27, p<0.01) and a small effect size, suggesting that those who suffered from a stroke were associated with completing less physical activity. Interestingly, MET-mins were not strongly correlated with a previous heart incident, although there is strong evidence suggesting that physical inactivity can be attributed to cardiovascular diseases (Lee et al., 2012). Regular exercise also reduces coronary heart disease, the risk of hypertension and other vascular diseases, thus lowering the risk of vascular disease, including stroke (Sattelmair et al., 2009). Although, the lack of previous heart incidents influencing MET-mins in this population could also be attributed to taking medications that affect the vascular system. There were 26 (27.4%) participants who reported having a previous heart incident. The participants' MET-mins levels (which are high, compared to their similarly aged peers), could also be the major influencing factor in this correlation. It is possible, for example, that the positive health effects because of their high levels of physical activity MET-mins may reduce the influence that their previous heart incidents have had on their current lifestyle scores and physical activity levels. Moreover, high MET-mins correlated with lower PWV scores, which can be indicative of a lower risk of heart incidents for those participants.

Smoking, within the study population, was a low occurrence, with only 2.1% of the population having reported being a previous smoker (N=2), but no one was currently smoking. Due to the low number of smokers in this sample, smoking was not entered into the multiple hierarchical regression to be analysed as a covariate. We could also anecdotally comment, that due to the low number of reported smokers, this could be another factor which has attributed to overall positive general health and fitness of the sample, as smoking has an adverse effect on many aspects of health, including the vascular system.

5.2.3 Pulse Wave Velocity

PWV is regarded as the gold standard in arterial health measurement and can be used to predict cardiovascular risk more accurately than the more common measure of brachial blood pressure. In PWV, lower scores indicate healthier arteries which are typically associated with a lower risk of stroke and heart attacks.

According to SphygmoCor-XCEL, if a PWV is 12 milliseconds (m/s) or under, one has a normal risk of cardiovascular disease, heart attack, stroke and organ damage compared to a peer the same age (SphygmoCor-XCEL, 2012). It is important to note, that the levels of PWV measurements can be adjusted for a given age and blood pressure and therefore the cut-off level of 12m/s as the healthy limit, gradually increases with age. Within the participants studied, the PWV mean was 11.9 +2.4 (SD), with 47 of those participants recording a score below 12 m/s indicating a high percentage of the participants were at lower risk of developing heart attacks, stroke, and other organ damage.

The analysis found that four predictor variables correlated to PWV, including brachial systolic blood pressure, MET-mins (as detailed below), leg strength and aerobic capacity. The strongest positive correlation was between PWV and brachial systolic blood pressure (r=.50, p<.001), a strong effect size. Since PWV is tightly associated with the pressure involved with the heart moving the blood through the arterial system, this could be expected, as participants with higher PWV scores also recorded higher brachial blood pressure scores. Once again, the population tended to score lower systolic blood pressure readings than those who are considered at risk of high blood pressure/hypertension. The average brachial systolic blood pressure measures were 134.65 ± 15.24 (M, SD). Hypertension stage one is typically defined as having a systolic blood pressure of 140 or higher and having diastolic pressure of 90 or higher (ACSM, 2014). Additionally, all subjects scored within positive ranges for their adjusted arterial stiffness limit, as indicated by individual PWV (generated by the SphygmoCor), these ranges were adjusted for each individual's age and brachial blood pressure scores. Most participants (N=77) reached the "optimal" score, and an additional five subjects' (N=83) met the "normal" score for their arterial stiffness limit (as captured by the SphygmoCor-XCEL). This further indicates that this population had healthy veins and arteries.

This study showed that unhealthier, or higher PWV is associated with lower aerobic capacity scores in physical activity tests such as the six-minute walk test and the sit to stands test. The participant's unhealthy vascular system could be because they do not partake in enough exercise, and limited health fitness can affect the arterial function and the cardiovascular system. Leg strength correlated negatively with PWV (r=-.23, p<.05), where the higher the PWV, the lower number of sit-to-stands completed. Aerobic capacity was also negatively correlated with PWV (r=-.19, p<.05), indicating that those with reduced aerobic capacity travelled less distance during the six-minute walk test and had higher PWV values, with small effect sizes. Previous research largely agrees that physical inactivity is indicative of adverse cardiovascular health (Lee et al., 2012), and cardio-respiratory fitness is associated with lower mortality rates from heart disease (ACSM, 2010). In addition, the ability to undertake endurance fitness is reliant upon adequate cardiovascular health. Albin, Brellenthin, Lang, Meyer, & Lee (2020) predicted similar findings with another cardiovascular test (400-meter walking test) in which high scores of this test were associated with healthier levels of PWV (below 10m/s). This research also aligned with what was found in other studies that higher PWV was associated with poorer cardiovascular health.

5.2.4 Physical Activity

One major finding was that the participants in this study were relatively physically fit. This was evident through the range of test results, particularly when 93 out of the 94 participants were meeting or exceeding guidelines as recommended by the 2018 Physical Activity Guidelines Advisory Committee, the WHO (2011; 2018) and the New Zealand Older Adults Guidelines (MOH, 2013; 2017). The participants' average MET-mins per week were 4557.8 ± 2836.22 (M, SD), compared to the guidelines which recommend 500-1000 MET-mins per week (approximately). These findings are inconsistent in comparison to the 2011/12 New Zealand Health Survey (MOH, 2012), which indicated that there were larger proportions of older adults aged 65 plus who did not meet recommendations for physical activity. The survey results showed that after the age of 65 years only 55% of men and 47% of women were physically active, and this decreased to 38% of men and 28% of women when reaching the age 75 and over. Nevertheless, with nearly 99% of this study population exceeding these guidelines, it further proves that the subjects involved in this research were of good physical fitness, which could have been for a range of reasons. It is also likely that the fitter residents of the retirement homes, were more likely to enrol, as it is predominantly a physical activity-based study.

However, it is also possible that the subjects in the study may have over-reported their results. Social desirability bias is a consideration for researchers administering self-report surveys, and over-reporting levels of physical activity can be common (ACSM, 2010; Warnecke et al., 1997 as cited in Sallis & Saelens, 2000). Due to the self-reported nature of the physical activity section of the survey, perhaps over-reporting of individual physical activity has occurred. Moreover, given the participant's ages and the memory loss which is commonly associated with older age (Baranowski, 1988 as cited in Sallis & Saelens, 2000), there is also a chance that some of the participants may have misreported responses on the questions which required the recall of past behaviour.

Regarding the individual's actual physical activity levels, social connectedness, and social interaction in the villages could also play a role in the increased MET-mins acquired by participants. Supportive environments have been known to be associated with having a positive influence on engaging in new behaviours, such as regular physical activity (WHO, 2018). Anecdotally, living in the retirement community and seeing others exercise, or exercising with others could have a positive effect on staying active, especially compared to community-dwelling residents living on their own.

Furthermore, higher MET-mins have been found in this sample to moderately, positively correlate with aerobic capacity (r=0.24, p<.05), the ability to complete longer distances in the six-minute walk test, a small effect size. An intervention study by Eyigor, Karapolti & Durmaz (2007) shared similarities with the current study, whereby older female adults who participated in an eight-week physical activity program significantly improved their physical performance in the six-minute walk test post-intervention. Another 12-week intervention involving older sedentary women (Nakamura, Tanaka, Yabushita & Shigematsu, 2007) shared similar findings that those who participated in a ninety-minute exercise program three times a week (compared to once and twice a week) showed significant improvements in post-intervention measures, including cardiorespiratory fitness (p<.05). Higher MET-mins are negatively associated with lower brachial systolic blood pressure (r=-.22, p<.01), where higher physical activity levels are indicative of better heart health and lower blood pressure. MET-mins and balance are also positively correlated (r=0.32, p<.05), whereby higher MET-mins are associated with a higher level of balance that was achieved. Additionally, MET-mins and PWV (as discussed further below) (r=-0.31, p<.01) were positively correlated.

The relationship between MET-mins and various health variables were further analysed using two hierarchical regression models. The first model was used to control for four covariates, namely age, stroke, heart incident, and diet, which have been previously identified to influence vascular health and physical activity levels. Model 1 indicated that age, heart incident, stroke, and diet predicted 20% of the variance in MET-mins. However, age was the only significant predictor of MET-mins in Model 1. Once the covariates were controlled for, Model 2 was analysed including the eight predictor variables, namely, PWV, BMI, leg strength, grip strength, balance, aerobic capacity, average heart rate, and brachial systolic blood pressure. When all predictor variables were included, it was indicated that the eight variables could predict 17.1% of the variance in MET-mins. These variables became a significant predictor of MET-mins at the $p<.05$ level after already controlling for the four covariates. However, the R-Square change between Model 1 and 2 was only 5.6%, meaning there was only 5.6% of additional variance added when predicting MET-mins after the covariates were controlled for. The R-Square change value was not statistically significant, and Model 2 did not have a significant F change, which means the addition of the predictor variables had no statistical significance on predicting the outcome of MET-mins in this population. Nevertheless, even though some of these variables have been found in other studies to be predictors of MET-mins in older adults, this study can suggest that age is contributing significantly to the participant's levels of MET-mins, even when other health-related variables are entered into Model 2.

Overall, when analysing physical activity using Model 1, age was able to predict MET-mins, when the covariates were analysed. However, this was not the case when the independent variables in Model 2 were analysed, suggesting that no variables (apart from age) were able to significantly predict the outcome of MET-mins minutes in this study population.

5.2.5 Pulse Wave Velocity and MET-minutes

High levels of physical activity have been positively linked to healthy arteries (Nelson et al., 2007). On the other hand, literature has also indicated that there are some uncertainties regarding vascular health and physical activities (Lacey et al., 2015), particularly around the strength of the association between MET-mins and vascular disease. The current study found a moderate, negative correlation between PWV and MET-mins (r=-.31, $p<.05$), in with a higher PWV score correlated with a lower score of total MET-mins (low exercise) and vice versa. Participants in this study recorded correlations between higher MET-mins minutes per week (more physical activity) and lower PWV scores (healthier arteries). Therefore, suggesting that larger amounts of physical activity are associated with healthier arteries. This finding is contrary to Armstrong et al. (2015) who observed an upturn of vascular risk among active women aged 50-65 (in their population of 1.3 million) who were completing daily strenuous activity, compared to those reporting similar activity a couple of times per week. However, they also reported that those who recorded moderate physical activity were at less risk of vascular disease compared to their inactive counterparts. Further research on determining thresholds and potential limits for higher MET-mins and physical activity would help clarify this. Literature indicates that the more active and more regular exercise that is partaken, also reduces coronary heart disease, the build-up of plaque in the arteries, the risk of hypertension and other vascular diseases along with providing other health benefits (Nelson et al., 2007).

Given the homogeneity of the MET-mins of the participants, there were no emerging groupings based on both MET-mins and PWV. For example, due to limited numbers, we were unable to split the subjects into groups, e.g., sedentary, and active to compare both group types and the potential associations within and between them.

Further research with a more heterogeneous group of physical activity levels may be able to determine the optimal physical activity levels for the best health outcomes among older adults. For example, if there were a larger distribution of the population and more subjects to test it would be possible to split the subjects into three or more groups for comparison. One group containing participants who did not meet the guidelines, and one or two other groups with participants who met and exceeded guidelines. In that case, the groups could be compared using ANOVA to determine if and how their health indicators vary and how these three groups of activity levels influence the PWV of the population.

Within the data collected for this current study, almost all the participants met the physical activity guidelines, so it is difficult to analyse further without a larger sample of physically inactive participants with which to compare. It is well established that there is a strong association between arterial health and physical activity in adults (Sattelmair et al., 2009), but less is known in older adults. In future studies with a larger pool of subjects, it would be valuable to analyse the effect of meeting physical activity guidelines on individuals' PWV scores.

5.2.6 Balance

Balance in older adults is a factor associated with health, and impaired balance in older adults increases the likelihood of falls and injuries associated with these falls (ACSM, 2010; Nelson et al., 2007). Results showed that the strongest positive correlation was between MET-mins and balance *(r*=-0.32, *p*<.05) where the higher MET-mins associated with better balance, a medium effect size. Increased participation in physical activity and the ability to be more active provides benefits in multiple areas of health, including balance, agility, and coordination. A longitudinal study by McMullan, Bunting, McDonough, Tully & Casson (2019) found an association between 'free-living' physical activity and a comprehensive, six functional measures of balance in community-dwelling older adults. They observed that physical activity is linked to improved balance during the short term, as an additional MET minute per week, over a one-week period can improve balance by 4% and can improve by 5% if accumulated over a two-year period. Research by the CDC (2017) has also indicated that older adults (aged 65 plus) who cannot perform level 3 ACC balance activities (a tandem foot one in front of the other stance) without losing balance for 10 seconds are at an increased risk of falling (CDC, 2017). However, within this sample over 92% of the subjects completed the tandem stance, indicating they were at less risk of falling compared to their peers scoring lower than 3 for balance. Moreover, this population also recorded high MET-minutes scores, thus showing, that remaining as active as you can, whilst you get older, can improve balance ability in the short and long-term and further reduce the risks associated with falling.

Balance was also moderately correlated to leg strength (*r*=0.38, *p*>.01) and grip strength (*r*=0.24, *p*>.05), both relative measures of muscular strength. These positive associations suggest that the higher balance level attained is associated with the higher number of repetitions during the other tests the participants could complete during the strength test. This aligns with literature, as balance has been shown to directly aid in improving leg strength particularly in older adults. Functional fitness, such as neuromuscular exercises, including balance, agility, coordination, and proprioceptive training (ACSM, 2014) are important and effective in reducing falls if performed 2-3 days a week. Reduced muscle strength is a factor for falls, particularly in the older adult population (Sherrington et al., 2011). Those who are frequent fallers or those who have mobility issues may benefit from specific training such as those listed above, in addition to other components of health-related fitness (ACSM, 2014). The increased improvement of mobility and strength influences overall fitness and the ability to complete daily activities that are part of day-to-day routine, which is especially important for older adults continuing to live an independent lifestyle.

5.2.7 Grip and leg strength

Muscular strength is also a vital aspect of health for older adults because it is necessary for efficient movement and everyday tasks. There are a range of factors that contribute to the loss of strength and muscle mass in older adults, often referred to as sarcopenia (Seguin & Nelson, 2003). Sarcopenia limits the ability of the muscles to function, by the age of 65 years, approximately 25% of maximal force-generating capacity is lost, and this can increase to 40% over a lifetime (ACSM, 2010) this can further lead to an increased risk of developing other conditions such as osteoporosis. However, literature does suggest that exercising, and specifically strength-based activity helps to reduce the rate of these declines (ACSM, 2010; Taylor, 2014). In this study sample, there were no strong correlations between PWV and grip strength (r= .04, p> 0.5) nor brachial systolic blood pressure (r=-.06, p= n.s.). The findings of this population do not support previous literature, other studies, such as Albin et al. (2020) most recently, predicted that higher muscular hand-grip strength associated with healthier PWV recordings in older adults (aged 72 years old). Results for the combined hand-grip strength test in the sample were 52.09 ± 16.33 kilograms (M, SD), they were compared to the norms for age and gender, adapted from The Canadian Physical Activity, Fitness and Lifestyle Appraisal (1996) as cited in ACSM (2005). However, it is important to note that the norms are only provided for the age range 60-69 years, in which only 1 male and 5 females from this sample would fit this age criterion. When plotting all participants' scores on the norms scale, including those 70 years and older, a low percentage recorded an “average” or “above average” score, with only 4 men, and 19 women who respectively reached these levels of physical activity. Thus, the remaining 70 participants scoring either “below average” or “poor” on the norms table (for their gender), further indicating that most of this sample had low grip strength regardless of their age. These results differed to other studies, which indicated that grip strength had been linked to arterial stiffness. As Gale et al. (2007) discovered, lower hand-grip strength was indicative of increased all-cause mortality of cardiovascular diseases (and cancers) in men. The latter study explored the mortality rate of participants aged 65 plus years in a 24 year follow up. However, there is no indication that grip has a strong relationship with arterial health measures in older adults in this sample.

5.2.8 Quality of Life (QOL) Variables

Studies have reported that older adults with higher physical activity levels also had a higher perceived quality of life (Sattelmair et al., 2009). Conversely those with lower perceived quality of life measures are linked to the decline in bodily functions and abilities due to age-related changes (Lima et al., 2009). This was also reiterated in this study as four of the eight predictor QOL variables were strongly, positively correlated to MET-mins, all medium effect sizes. The strongest positive correlation was between MET-mins and physical functioning (r=.34, p<.0001), whereby high levels of MET-mins correlated with a high score of physical functioning, reflecting that the more exercise subjects are participating in, the better physical functioning they self-reported. There was also a positive correlation between MET-mins and general health (r=.29, p<.005), whereby higher MET-mins were correlated with a higher general health score, once again being echoed by the literature, as commonly the more exercise that is partaken, the higher health scores one will require. MET-mins were also positively correlated with physical activity limits due to emotional problems (r=.28, p<.006). Finally, METs and role limitations due to physical health were positively correlated (r=.24, p<.022). The analysis of MET-mins with the QOL variables have all showed positive relationship leaning towards to the more MET-mins undertaken, the more positive the health outcomes recorded for this population. These findings were also shared by Eyigor et al. (2007), whose study observed an eight-week exercise program for older women aged 70.3 ± 6 years (M, SD). One of their research measures was the SF-36 survey, and they found that all QOL variables improved from pre to post-intervention. This exercise program includes exercise performed 3 days per week of one-hour duration and walking for 30-minutes for a further 2 days during the week. This was described as an intermediate intensity, and although we cannot compare that intensity to our measure of energy expenditure, there was still significant improvements of all performance tests within their population, exercising at intermediate intensity for four hours per week.

However, only three out of the eight predictor QOL variables were strongly negatively correlated with PWV. Interestingly, these were also three of the four factors that correlated with MET-mins as per discussions above, which could indicate the further link of MET-mins strong correlation with PWV. The strongest negative correlation was between PWV and role limitations due to physical health (r=-.27, p<.015) when lower PWV was positively correlated to role limitations due to physical health (good). There was a negative correlation between PWV and role limitations due to emotional problems (r=-.24, p<.027), where a high PWV score, was correlated to a lower emotional score, suggesting similarities to the study by Tiemiers et al. (2003) which showed that increased arterial stiffness (the measurements taken from the carotid artery/femur) were associated with higher rates of depression later in life.

Furthermore, a negative correlation between PWV and physical functioning occurred (r=-.22, p<.05), whereby a higher PWV correlated with lower physical functioning.

5.2.9 Village location and facilities

Older adult's ability to participate in physical activity, and specifically to improve one's health is influenced by many factors including the physical environment (Brown, Rosenkranz, Kolt, & Berentson-Shaw, 2011; WHO, 2018). Not all participants in this study came from the same physical environment, and there were the obvious differences like the three different villages locations, as well as individuals various independently living setups along with the length of time they had lived in those villages. Results showed there was a difference between villages, in terms of numbers that were enrolled in the study and the health of those individuals. PWV scores over the villages varied, with village 1 recording the lowest mean score of 11.13m/s ± 2.40 (M, SD), village 2 recording the second lowest PWV average score of 12.64m/s ± 2.79 (M, SD), and then village three with an average PWV score of 12.65m/s ± 2.10 (M, SD). A PWV score that is 12 m/s or less is associated with healthier arteries and less risk of vascular incidents (SphygmoCor XCEL, 2012). Although in this study, only village 1 recorded an average score of below 12m/s on average, village 2 and 3 were only slightly elevated in comparison, recording marginally above 12m/s. Additionally, along with these health scores, there could be other factors contributing to the results among the participants of the different villages.

The environment also influences a person developing and maintaining healthy behaviour throughout life (WHO, 2018). The facilities, including the physical activities offered at the villages varied, with village 1 having the most extensive list of facilities and programmes including a pool, gym, grass courts and recreational activities, along with fitness classes on offer to residents. Village 2 had fewer facilities, none specifically for physical activities and only offered limited fitness classes for participants. The third village had outdoor sport and recreation facilities, and some programmes on offer, with another health and recreation complex being under construction at the time of testing. In village 3, it could also be noted that more of the residents participated in activities outside of the village for fitness and health. Anecdotally, participants from village 3 commented to the researcher that they were looking forward to using the fitness facilities when they became available to use.

Participants from village 1 and 3 were more active than their counterparts in village 2. However, village 1 did seem to have more variety, and the participants were, in general, more 'fit overall' than those from other villages. This was not necessarily indicated by the PWV average scores for each village, but by the self-reported MET-mins for each village also. Village 1 recorded the highest MET-mins average of 5050 ± 2801 per week (M, SD), village 3 was similar with 4414 ± 2744 MET-mins per week (M, SD) and village 2, the less active with MET-mins of 1151 ± 552 (M, SD) per week. More sedentary lifestyles were observed in village 2 in comparison to the other villages, however, village 2 only equated to approximately 6.3% of the total population tested, and the residents who took part may have still been more active than others who did not sign up to the study in that setting.

Age of the members of each retirement village also varied. Village 1 had an average age of 77 ± 5.9 years (M, SD), village 2, 85 ± 3.33 years (M, SD) and village 3, 80.51 ± 6.45 years (M, SD). Considering, we know from the correlations above, age, also is a major determinant of MET-mins and PWV within this population, and the range of MET-mins and PWV within the village settings, we can with some certainty 'rank' the villages from healthiest to least healthy. For example, village 1 would be the healthiest population, their participants on average, were the youngest group, with the lowest PWV scores (below 12 m/s on average) and the most cumulative MET-mins, however, they also make up the majority population of the study at approximately 54.7%. Village 3 would be classified as the second healthiest village, with a slightly higher average age group, slightly lower MET-mins and PWV scores (just over 12 m/s on average) and they are the second largest makeup of the sample of approximately 39%. Finally, village 2 the third healthiest, and smallest population in the study of approximately 6.3%, containing the oldest aged participants on average, but had a similar PWV score to the other two villages, although slightly above the 'healthy' 12 m/s on average, but recorded significantly lower overall MET-mins levels per week in comparison. Although, as discussed earlier, their average MET-mins were still significantly higher than the recommended levels of physical activity advised by multiple guidelines. It is also clear that the average 'health' and 'fitness' of these villages decreased as the village average age increased.

The activity levels and the opportunities to be active within the villages could be linked to the socioeconomic status of each of the areas that the villages were located. Village 1, for example, was positioned in a higher socioeconomic area in Christchurch than the other two villages. Deciles ratings are a measurement used to rate the areas schools in which are located in. School decile ratings are generated from measuring how many students live in poor communities (low socioeconomic) (Ministry of Education, 2020). Lower socioeconomic status can equate to an area with reduced facilities and families/residents with lower incomes, whereas higher socioeconomic status can indicate higher income patterns and more resources in the community/area. Drawn from the Ministry of Education (2020), the schooling facilities near (within 1km) the participating villages were analysed to compare the socioeconomic status of the communities. The school, (within 1km) of village 1 was identified as decile 9. For village 2, the closes schools (within 1km) are decile 3-4, and for village 3 a similar pattern, the closest school (within 1km) was decile 3. The villages in higher socioeconomic areas would tend to obtain residents who are of higher economic status and are therefore more expensive areas and communities to buy and/or live in and usually have more access to resources in their communities (including physical activity equipment and accessibility). Potentially, wealthier residents can afford medical treatment and or health benefits which may further improve their health outcomes. A contributing factor in participation of physical activity in older adults was identified as 'neighbourhood' in a survey by Annear et al. 2009 (as cited in Brown et al., 2011) who found that those older adults residing in more affluent areas, were more likely to participate in leisure-time physical activity than who did not, as they had a more positive attitude to their own physical and social environment.

Retirement villages with a larger range of facilities and physical activity programme options can provide more opportunities to be active and healthy. Easy access to local programmes and facilities has been identified as one of the specific enablers for New Zealand older adults to participate in physical activity. Other enablers included the physical and social environment, social support and having positive experiences (Brown et al., 2011). Supportive environments are further important for older adult's health, as they allow people to be involved in what is important to them (WHO, 2018). Villages with a supportive environment, with likeminded people, might also help increase physical activity motivation and routine, as is often the case in group fitness classes.

5.3 Limitations

There were some methodological limitations which were present in this study, primarily relating to subject recruitment. First, the inclusion criteria limited the population to retirement villages only, instantly excluding community-dwelling older adults, and therefore, the results can only pertain to this group. Additionally, within those villages, the participants who were willing to be part of the study would only be accepted if they were residents who were independently living and could also pass the inclusion criteria including being able to complete the six-minute walking test. The recruitment process relied on self-selection, which created bias within this population, but it was the only realistic method available for completing this study. The study itself could have inadvertently attracted fitter subjects or participants who were already involved in exercise and/or frequent physical activity, over their less fit and able counterparts in the villages, due to the nature of the research. The researcher was also required to retest the PWV of several participants, which also impacted the reliability of the study and is a further limitation. Some of the data were collected at different times in the day and then retested on another day at another time (due to availability), which may have affected the reliability and validity of the data collection. Due to some PWV retesting times varying from original test times, it is possible that diurnal variation could have impacted PWV correlations with independent variables collected at a different time on a previous day. As Bodlaj, Berg, & Biesenbach (2007) study advised that time of day influences blood pressure, both the systolic and diastolic, sharing that the mean blood pressure, was significantly lower at 17:00 hours compared to those at 8:00 hours.

Self-reporting recall bias and/or under/over-reporting could also be a limitation within this study. A range of factors could be affecting this, such as feeling the desire to report what is socially accepted and to give a desirable answer (Ruiz-Comellas, 2014; ACSM, 2010). Due to the nature of the survey, being self-reported, there is potential for individuals to either under or over-report, especially in relation to their own levels of physical activity. As the subject are participating in a physical activity study, it could be more likely that they over-report (with or without realising). The age of the participant could also be affecting their ability to recollect what activities were completed over time. All these self-reporting errors could cause skewness to the data and could affect the validity and is another limitation to note for the results.

Given the homogeneity of the population in this study, especially the MET-mins of the participants, this has resulted in no emerging groupings being able to be based on both MET-mins and PWV. Furthermore, due to the sample size in this study, during analysis the subjects were unable to be split into activity groups, e.g., sedentary, and active. This split would have been valuable to have been able to compare associations within and between MET-mins levels and PWV.

This unique sample of participants were also very physically fit for their age, which does also limit the ability to generalise this current study results to all older adults. However, the results can be generalised to the sample population of the three villages in Canterbury that were involved in the testing process. Nevertheless, due to the collection method, and other factors, it makes it tenuous to suggest that the results could be generalised to the wider population at these retirement homes. Larger sample size in future studies will increase the statistical power for this type of study.

5.4 Implications of Research

This research has established that there are important implications for physical activity for older adults in Canterbury, New Zealand. A potentially positive and unintended consequence of the study was perhaps that it motivated people in the older age retirement population to keep moving and stay active by simple daily lifestyle activities, through self-reporting and reinforcing their understanding of their reported level of activity they are completing.

From the results analysed in this study population, there is an obvious association between a larger accumulation of MET-mins per week and better overall health indicators, including their PWV scores (lower and healthier scores). In this sample, the physical activity by individuals greatly exceeded those recommended guidelines, and further was indicative of better health outcomes in this study. All health outcomes were positive, with exception there was no significant association between grip strength between both MET-mins and PWV, which was especially surprising. Grip strength was also the lowest cumulative health result as a comparative measure within this sample.

As detailed above, it was clear from early analysis in this study, that age had such a strong influence when measuring PWV and MET-mins levels among older adults. This has meant it was difficult to generate recommendations about physical activity levels without having larger age groups within which correlations could be run between those groups.

Implications and advice from the measures taken and results presented in this population would be simple, to encourage retirement homes to inspire older adults to be as active as possible throughout their ageing years. If possible, also making improvements to facilities and create other activity settings (e.g., classes or group activities) that further provide residents additional opportunities to be physically active outside of their home and within a safe and encouraging environment. Furthermore, recommending older adults to be as active as they can around their home, partaking in daily lifestyle task as long as possible and simply encouraging being active. As it has been identified that more participation in physical activity will help contribute to overall physical activity levels, as seen within the MET-mins of this study sample. The higher physical activity levels of the participants in this study associated with positive effects on vascular health, aerobic capacity, balance and QOL health outcomes for older adults living in retirement villages in Canterbury.

5.5 Recommendations for Future Research

Future studies could investigate similar health parameters to this study but amongst a larger sample size to discover if there is a most effective level of physical activity that is required to maintain good cardiovascular health, or if there is a harmful level and therefore a threshold of physical activity levels that could be seen within different older adult age groups, given the physiological changes (health declines) that occur with age. Larger sample size could allow analysis by several age groups or by MET-mins. Larger distributions would enable thresholds and dose responses to be calculated and evaluated.

To mitigate similar issues to those listed in the limitations above, it would be recommended to incorporate an inclusion criterion which collects the subjects' physical activity level first, so then the researcher can determine if two or three physical groups can be created at the outset of the study. To gather physical activity levels, (without the potential factor of bias or inaccurate recall) another option would be to include use of a more objective measurement tool like an accelerometer which unlike questionnaires do have the ability to capture the intensity of movement of physical activity, without self-reporting bias (ACSM, 2010).

It would also be of interest to collect a 24-hour recall diet amongst this population to track the effect of diet on their vascular health and other scores which showed positive correlations in this research. To delve further into the nutrition of the participants in this older adult age group would be especially important to determine the relationship between the dependent variables of PWV and MET-mins and their relationship to nutrition.

Revisiting the population in a longitudinal study to monitor the participants MET-mins and PWV over a longer period would be another valuable investigation to undertake. To be able to witness the ongoing age-related changes in the body and to see how that affects a subjects MET-mins levels and PWV health with a variety of health parameters. A longitudinal study would allow the ability to potentially indicate the most effective physical activity level for maintaining health over different age brackets and groups, as mentioned above. However, a longitudinal study would pose its own risks of participant drop-out due to ageing and decline and it could be harder to recruit for as it would involve a larger time commitment for participants.

Chapter 6

Conclusion

It is well understood that physical activity is associated with improved health outcomes in adults but whether this is the case in older adults especially those living in retirement villages in unclear. This study used unique measures to test the arterial stiffness, and overall MET-mins, lifestyle physical activity levels in older adults who were living independently in retirement villages. PWV is the gold standard in vascular health testing of arterial stiffness, and these findings have important implications for physical activity for the older adults in this study. Overall, the research indicated that the sample population was healthier than average, as they exceeded guidelines set by WHO, MOH, and New Zealand Physical Activity Guidelines with nearly 99% of the study sample achieving these guidelines.

As the population gets older in New Zealand (and globally), it is important to have understanding around preventative healthcare, so that the ageing population is ensured that their longer life expectancy can be lived to the fullest without those increased years being affected by ill health (MOH, 2011).

Cardiovascular disease is the largest cause of death in New Zealand (Heart Foundation, 2020a). Therefore, it is important to promote physical activity to not only prevent heart disease and other debilitating issues for older adults and to also assess heart health in an accurate way, such as arterial stiffness for an early detection approach.

In response to the lack of research involving older adult's physical activity levels, and in particular the levels of physical activities effect on vascular health measures, this thesis has further explored the strength of the association of PWV and MET-mins with a range of health parameters in older adults residing in three Canterbury retirement facilities.
The findings have identified that the groups involved in this study were certainly healthy and active on a range of scales. They could further anecdotally state that within this specific sample that the more physical activity, MET minutes that retirement village residents acquire over the week the better PWV they will attain and strongest overall health indicators they will produce. This, however, can only be associated with the sample population at the three villages tested in Canterbury and is not generalised to the overall population of older adults due to the small sample size and statistical power. However, an

important suggestion could be to ensure retirement villages are giving their residents every opportunity available to be active and stay active in their ageing years.

There is still a need to understand the association between physical activity, PWV, and other health indicators on a deeper level of analysis. A suggestion for further research would be to explore the association between different age groups and assess what the most effective level of physical activity is required to maintain good cardiovascular health and longevity in later life.

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Appendix A

Recruitment Email

Dear _____________ Retirement Village,

My name is Hannah Hill and I am Masters Student at Lincoln University researching "the dose-response relationship between physical activity and vascular health, strength, balance and quality of life in a cross section of older adults".

The aim of this project is to examine the relationship of lifestyle physical activity levels (METs) on health parameters. There is debate over the appropriate level of exercise for adults over the age of 65 and this research is seeking evidence to inform that debate.
I am currently recruiting retirement community residents for this study who live independently (without care or assistance) at your retirement organisation. We seek participants who are physically capable to partake in a fitness test (6-minute walking test, sit/stand balance test and arm muscular strength test). Additionally, they must be mentally fit to complete a 20-minute questionnaire which requires them to recall their lifestyle activities over the last 3 months. The cross-sectional nature of the data collection requires that the participants are tested on one occasion lasting approximately 1 hour (questionnaire and physical measurements will be completed at testing location). The findings will be used to evaluate the dose-response of physical activity on vascular health, muscular strength, balance and fitness.

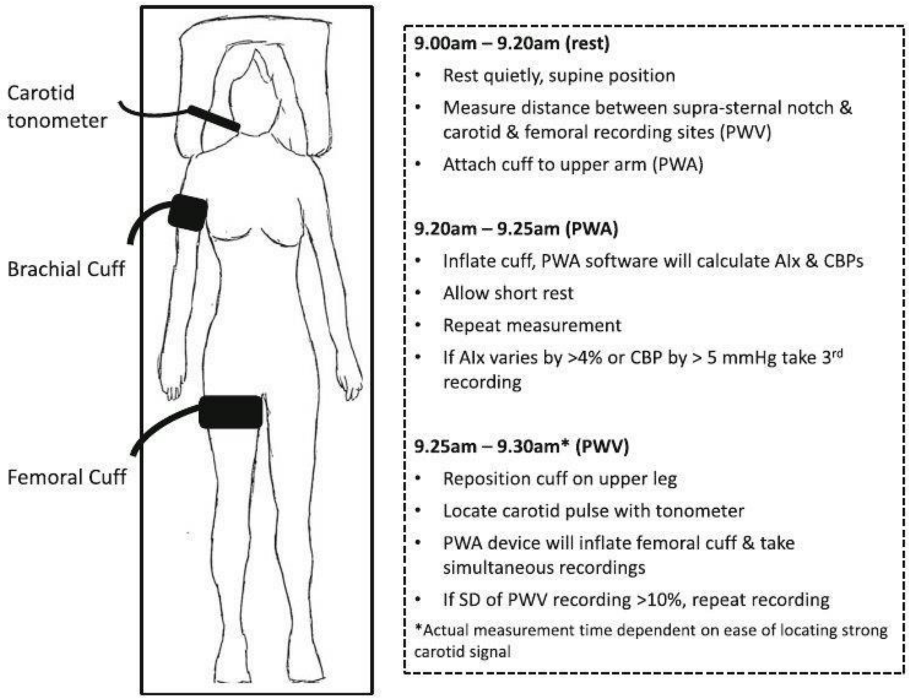
The type of data to be collected will be physical and mental health using questionnaires as well as physiological measurements (listed below). Questionnaire items are about physical activity (YALE Physical Activity Questionnaire) quality of life (SF-36 Health Survey), diet (diet-related questionnaire) and demographic information such as age, sex, and ethnicity. Both the YALE Physical Activity Questionnaire and SF-36 Health Survey have been tested for reliability and validity in older adults. Participants may leave the study at any time during the testing session and they may skip any questions they choose. The physical tests carry minimal risk to the targeted participants who must currently live independently to participate. The 6-minute walk test will induce an increased heart rate, therefore interested participants must comply with the physical fitness standards set forth on the physical activity readiness questionnaire prior to enrolment in the study. As a further safety precaution, I am a first-aid certified researcher and I will be observing participants during physical tests.

The following physical health parameters will be collected:

- Height/weight
- Blood pressure/resting heart rate
- Strength and balance based testing (sit and stand, arm strength, balance)
- 6-minute walk test for fitness
- Vascular health parameters

Vascular health parameters
A non-invasive measurement using the SphygmoCor Xcel (see image below) will be used to collect the blood flow velocity (the gold standard in vascular health) and the augmentation index (arterial stiffness).

This is similar to taking blood pressure on the arm and on the leg, but participant lies on a bed during measurement.



I have attached an advert flyer which explains what the research process entails for residents. If you agree that _________________ residents would be a good fit to opt to participate in this study, I would be excited to discuss this further with you.
If you have any questions, please do not hesitate to contact me. I look forward to hearing from you.

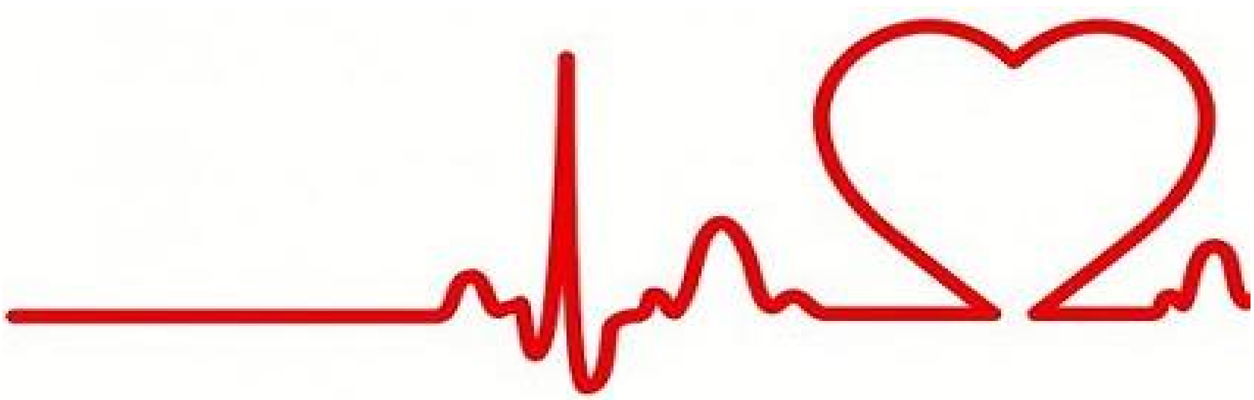
Thank you for your consideration.

Kind Regards,
Hannah Hill
Master of Applied Science Student, Lincoln University.
Hannah.hill@lincolnuni.ac.nz
Ph. 027 228 3005

Appendix B

Participant Recruitment Flyer

Participants Wanted!



Would you like to know the age of your arteries?

You are invited to participate in a research project testing physical activity and arterial health of older adults!

If you are:

- ✓ **Living independently in a retirement community in Christchurch**
- ✓ **At least 65 years of age**
- ✓ **Physically able to participate in six minutes of continuous walking**

Then we want you! We will test:

- ✓ **Age of arteries (non-invasive procedure similar to blood pressure)**
- ✓ **Strength and balance**
- ✓ **Fitness**
- ✓ **Physical activity levels, diet and wellbeing**

For more information please contact the Primary Researcher:
Hannah Hill
Master of Applied Science student, Lincoln University.
Hannah.hill@lincolnuni.ac.nz
0272283005

Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH • NEW ZEALAND

Appendix C

Research Informaiton Sheet

Lincoln University

Faculty of Environment, Society and Design

Research Information Sheet

You are cordially invited to participate as a subject in a project entitled “dose-response relationship between physical activity and vascular health in a cross section of older adults”.

What is the aim of this project?
The aim of this project is to examine the relationship between physical activity and health parameters among older adults. There is debate over the appropriate level of exercise for adults over the age of 65 and this research seeks evidence to inform that debate. The findings will be used to evaluate physical activity level on muscular strength, balance, fitness and arterial health. Participants will benefit by receiving the results of these health tests at no financial cost.

What types of participants are being sought?
This study will employ the following **inclusion criteria**:

5. You are living independently in a retirement community in Christchurch
6. You are at least 65 years of age
7. Physically able to participate in a 6-minute walking test
   (Prior to participation, you must complete and pass the Physical Activity Readiness Questionnaire which we will send to you).

What will I be asked to do?
Your voluntary participation will involve a one-hour period of your time taken to conduct general health tests. On an occasions which is convenient to your schedule at the allocated space at your retirement village, you will be asked to complete this fitness test which includes a 30-minute physical exam (measures below), a 10-minute cardiovascular exam, and a 20-minute questionnaire. The questionnaire contains items about your physical activity levels, lifestyle, wellbeing, and demographics.

- Height
- Weight
- Blood pressure
- Resting heart rate
- Health of arteries (non-invasive, similar to taking blood pressure, but while lying down.)
- Strength and balance based testing (sit and stand, arm strength, balance)
- 6-minute walk test for fitness

In the performance of the tasks and application of the procedures, there are no foreseen risks of your participation in the research.

What use will be made of my data?

Health results will be provided to you directly after the physical measurements, survey and walk test completed during the measurement period. The results of the project will be submitted for a Master Thesis, publication in academic journals and presented at conferences. The findings will be used to evaluate physical activity levels on arterial health, muscular strength, balance and fitness. Participants will not be able to be identified in any way and their details and data will be entirely confidential and may be assured of your anonymity. The identity of any participant will not be made public, or made known to any person other than the researcher, her supervisors, and the Human Ethics Committee, without the participant's consent. To ensure anonymity and confidentiality the following steps will be taken:

- Names and contact details will not be used as part of data dissemination
- Pseudonyms or code names will be used instead in any written or oral presentation
- No individual identifying information will be presented in public.

May I withdraw from the project?

You may withdraw from the project, including withdrawing any information you have provided, at any time up to 30th December 2018. You can do this by contacting Hannah Hill using the contact details set out below. Data withdrawn will be destroyed.

What if I have questions or want to learn more about the study?

If you have any queries or concerns about your participation in the project, or you want to learn more about the study, please contact Hannah. Hannah would be happy to discuss any any concerns you have about participation in the project.

What will happen next?

If you are willing to participate in this research, you will need to sign the attached consent form and return it to the researcher.
Hannah will then contact you in regards to scheduling a time for the measurements.

Thank you for your help.
This project is being carried out by:

Primary Researcher: Hannah Hill, Master of Applied Science Student, Lincoln University.
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Ph. 027 228 3005

Supervisor: Dr Catherine Elliot, Lecturer, Faculty of Environment, Society and Design
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This project has been reviewed and approved by the Lincoln University Human Ethics Committee.

Appendix D

Participant Consent Form

Participant Identification Number: __________

Consent Form

Name of Project: "Dose-response relationship between physical activity and vascular health in a cross section of older adults".

I have read and understood the description of the above-named project. I have also read the inclusion criteria and agree that I do fit the required criteria. On this basis I agree to participate in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may withdraw from the project, including withdrawal of any information I have provided, until 30th December 2018.

By signing this Consent Form, I provide informed consent to participate in this study.

Name of Participant: ____

Signed: ____ Date: ________________________

Appendix E

Physical Activity Readiness Questionnaire

Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH·NEW ZEALAND
New Zealand's specialist land-based university

Name: ____________________________
Date: ____________________________

PAR-Q FORM

Many health benefits are associated with regular exercise, and the completion of PAR-Q is a sensible first step to take if you are planning to increase the amount of physical activity in your life.
For most people physical activity should not pose any problem or hazard. PAR-Q has been designed to identify the small number of adults for whom physical activity might be inappropriate or those who should have medical advice concerning the type of activity most suitable for them.
Common sense is your best guide in answering these few questions. Please read them carefully and check YES or NO opposite the question if it applies to you.

YES	NO		
☐	☐	1.	Has your doctor ever said you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?
☐	☐	2.	Do you feel pain in your chest when you do physical activity?
☐	☐	3.	In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4.	Do you lose balance because of dizziness or do you ever lose consciousness?
☐	☐	5.	Do you have a bone or joint problem that could be made worse by a change in your activity?
☐	☐	6.	Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
☐	☐	7.	Do you know of <u>any other reason</u> why you should not do physical activity?

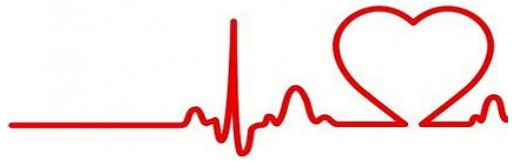
If you answered **NO** honestly to <u>all</u> PAR-Q questions, you can be reasonably sure that you can:
1. Start a graduated exercise program
2. Take part in a fitness appraisal

However, if you have a minor illness (e.g.,cold) you should postpone activity.

If you answered **YES** to one or more PAR-Q questions, you should consult your physician if you have not done so recently before starting an exercise program and/or having a fitness appraisal.

Appendix F

Questionnaire



Physical Activity & Vascular Health of Older Adults

Questionnaire

Project Title: "Dose-response relationship between physical activity and vascular health in a cross section of older adults"

Before beginning this questionnaire, have you?

- ✓ Read the research information sheet and asked any questions you may have?
- ✓ Signed the informed consent form?
- ✓ Completed 'Physical Activity Readiness Questionnaire' (and been cleared if needed)?

If YES to above, please continue with the questionnaire below.

If NO to above, please talk to the researcher.

This questionnaire includes questions about your demographics, a physical activity questionnaire, a quality of life questionnaire and a diet questionnaire. Please answer the questions to the best of your ability.

Thanks for your time.

Demographics

Date: ____

Name: ____

Age: ____________ Sex: M/F

Which village do you live in? ___________________________________

How many years have you lived there? __________________________

Occupation (before retirement): _______________________________

Type of living arrangement (e.g. townhouse, apartment): _________________

Do you have meals provided to you by the retirement village? Y/N

Do you attend the Exercise class at your village? Y/N

If so, what class? ____

How many times per week on average do you attend? ______________

Do you attend Tai Chi at your village? Y/N

How many times per week on average? __________________________

Do you attend Bowls at your village? Y/N

How many times per week on average? __________________________

Are you a smoker? Y/N

Do you have a history of heart disease/ heart incidents? If so what and when? ____

Do you have a history of stroke? If so when? ______________________

Yale Physical Activity Questionnaire

Part one: Please write how much time (in minutes or hours) you spent during the past week doing the common types of physical activity listed below.

Work	**Hours**	**Minutes**
Shopping (e.g., grocery, clothes)		
Stair climbing while carrying a load		
Laundry		
Unloading/ loading machine, hanging, folding only		
Washing clothes by hand		
Light housework: tidying, dusting, sweeping, collecting rubbish in the home, polishing, ironing.		
Heavy housework: vacuuming, mopping, scrubbing floors and walls, moving furniture, boxes or rubbish bins.		
Food preparation: chopping, stirring, moving about to get food items and pans		
Food service: setting table, carrying food, serving food		
Dish washing: clearing the table, washing / drying dishes, putting dishes away		

Light home repair. Small appliance repair, light home maintenance / repair		
Heavy home repair: painting, carpentry, washing/polishing car		
Other		
Yard Work	**Hours**	**Minutes**
Gardening, pruning, planting, weeding, digging, hoeing		
Lawn mowing (walking only)		
Clearing walks/driveways: sweeping, shoveling, raking		
Other:		
Care taking	**Hours**	**Minutes**
Older or disabled person (lifting, pushing wheelchair)		
Child care (lifting, carrying, pushing pram)		
Exercise	**Hours**	**Minutes**
Brisk walking		
Pool exercises, stretching, yoga		
Vigorous calisthenics, aerobics		
Tai Chi class at Village		
Cycling		
Swimming (laps only)		
Aquacise class		
Other		
Recreation	**Hours**	**Minutes**
Leisurely / slow walking		
Needlework: knitting, sewing, needlepoint, etc.		

Dancing: line, ballroom, tap, square etc.		
Bowling		
Bowls Indoor		
Bowls Outdoor		
Golf		
Racquet sports: tennis, squash		
Billiards		
Croquet		
Other:		

Part two: This section is about activities that you have done during the past month. Please tick or circle your answer.

1. **About how many times during the month did you participate in vigorous activities that lasted at least 10 minutes and caused large increases in breathing, heart rate, or leg fatigue, or caused you to perspire?**
   - □ Not at all (go to Q3)
   - □ 1-3 times per month
   - □ 1-2 times per week
   - □ 3-4 times per week
   - □ 5 + times per week
   - □ Refused
   - □ Don't know

2. **About how long do you do this vigorous activity/ies each time?**
   - □ Not applicable
   - □ 10-30 minutes
   - □ 31 – 60 minutes

□ 60 + minutes
□ Refused
□ Don’t know

3. **Think about the walks you have taken in the past month. About how many times per month did you walk for at least 10 minutes or more without stopping which was not strenuous enough to cause large increases in breathing, heart rate, or leg fatigue or cause you to perspire?**
   □ Not at all (go to Q5)
   □ 1-3 times per month
   □ 1-2 times per week
   □ 3-4 times per week
   □ 5 + times per week
   □ Refused
   □ Don’t know

4. **When you did this walking, for how many minutes did you do it**?
   □ Not applicable
   □ 10-30 minutes
   □ 31 – 60 minutes
   □ 60 + minutes
   □ Refused
   □ Don’t know

5. **About how many hours per day do you spend moving around on your feet while doing things? Please report only the time that you are actually moving.**

□ Not at all
□ Less than 1 hour per day
□ 1 to 3 hours per day
□ 3 to 5 hours per day
□ 5 to 7 hours per day
□ 7+ hours per day
□ Refused
□ Don’t know

6. **Think about how much time you spend standing or moving around on your feet on an average day during the past month. About how many how per day do you stand?**
   □ Not at all
   □ Less than 1 hour per day
   □ 1 to 3 hours per day
   □ 3 to 5 hours per day
   □ 5 to 7 hours per day
   □ 7+ hours per day
   □ Refused
   □ Don’t know

7. **About how many hours did you spend sitting on an average day during the past month?**
   □ Not at all
   □ Less than 3 hours
   □ 3 hours to less than 6 hours
   □ 6 hours to less than 8 hours
   □ 8 + hours

□ Refused
□ Don't Know

8. **About how many flights of stairs do you climb up each day?**
   Let 10 steps = 1 flight _________

9. **Please compare the amount of physical activity that you do during other seasons of the year with the amount of activity you just reported for a typical week in the past month**. For example, in the summer, do you do more or less activity than what you reported in the past month?

Please circle the appropriate score for each season.

	Lot more	Little more	same	Little less	Lot Less	Don't Know
Spring	1.30	1.15	1.00	0.85	0.70	-
Summer	1.30	1.15	1.00	0.85	0.70	-
Autumn	1.30	1.15	1.00	0.85	0.70	-
Winter	1.30	1.15	1.00	0.85	0.70	-

SF-36(tm) Health Survey

Instructions for completing the questionnaire: Please answer every question. Some questions may look like others, but each one is different. Please take the time to read and answer each question carefully by filling in the bubble that best represents your response.

1. In general, would you say your health is:

- □ Excellent
- □ Very good
- □ Good
- □ Fair
- □ Poor

2. Compared to one year ago, how would you rate your health in general now?

- □ Much better now than a year ago
- □ Somewhat better now than a year ago
- □ About the same as one year ago
- □ Somewhat worse now than one year ago
- □ Much worse now than one year ago

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf?

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

c. Lifting or carrying groceries.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

d. Climbing several flights of stairs.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

e. Climbing one flight of stairs.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

f. Bending, kneeling or stooping.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

g. Walking more than one mile.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

h. Walking several blocks.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

i. Walking one block.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

j. Bathing or dressing yourself.

- □ Yes, limited a lot.
- □ Yes, limited a little.
- □ No, not limited at all.

4. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

a. Cut down the amount of time you spent on work or other activities?

- □ Yes
- □ No

b. Accomplished less than you would like?

- □ Yes
- □ No

c. Were limited in the kind of work or other activities

- □ Yes
- □ No

d. Had difficulty performing the work or other activities (for example, it took extra time)

- □ Yes
- □ No

5. During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

a. Cut down the amount of time you spent on work or other activities?

- □ Yes
- □ No

b. Accomplished less than you would like

- □ Yes
- □ No

c. Didn't do work or other activities as carefully as usual

- □ Yes
- □ No

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

- ☐ Not at all
- ☐ Slightly
- ☐ Moderately
- ☐ Quite a bit
- ☐ Extremely

7. How much bodily pain have you had during the past 4 weeks?

- ☐ Not at all
- ☐ Slightly
- ☐ Moderately
- ☐ Quite a bit
- ☐ Extremely

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

- ☐ Not at all
- ☐ Slightly
- ☐ Moderately
- ☐ Quite a bit
- ☐ Extremely

9. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks.

a. did you feel full of pep?

- □ All of the time
- □ Most of the time
- □ A good bit of the time
- □ Some of the time
- □ A little of the time
- □ None of the time

b. have you been a very nervous person?

- □ All of the time
- □ Most of the time
- □ A good bit of the time
- □ Some of the time
- □ A little of the time
- □ None of the time

c. have you felt so down in the dumps nothing could cheer you up?

- □ All of the time
- □ Most of the time
- □ A good bit of the time
- □ Some of the time
- □ A little of the time
- □ None of the time

d. have you felt calm and peaceful?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

e. did you have a lot of energy?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

f. have you felt downhearted and blue?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

g. did you feel worn out?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

h. have you been a happy person?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

i. did you feel tired?

- ☐ All of the time
- ☐ Most of the time
- ☐ A good bit of the time
- ☐ Some of the time
- ☐ A little of the time
- ☐ None of the time

8. **During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?**
   - □ All of the time
   - □ Most of the time
   - □ Some of the time
   - □ A little of the time
   - □ None of the time

11. How TRUE or FALSE is each of the following statements for you?

a. I seem to get sick a little easier than other people

- □ Definitely true
- □ Mostly true
- □ Don't know
- □ Mostly false
- □ Definitely false

b. I am as healthy as anybody I know

- □ Definitely true
- □ Mostly true
- □ Don't know
- □ Mostly false
- □ Definitely false

c. I expect my health to get worse

- ☐ Definitely true
- ☐ Mostly true
- ☐ Don't know
- ☐ Mostly false
- ☐ Definitely false

d. My health is excellent

- ☐ Definitely true
- ☐ Mostly true
- ☐ Don't know
- ☐ Mostly false
- ☐ Definitely false

Diet related questions

1. **Do you usually eat fish two or more times per week?**
   - ☐ Yes
   - ☐ No
2. **Do you eat 5 or more servings of fruit and vegetables per day**? A serving is one medium apple, banana or orange, 1 cup of raw leafy vegetable (like spinach or lettuce), ½ cup of cooked beans or peas, ½ cup of chopped, cooked or canned fruit/vegetable or ¾ cup of fruit/vegetable juice.
   - ☐ Yes
   - ☐ No

3. **Do you eat 3 or more servings of whole grains per day (**wheat bread, whole grain pasta, brown rice, oatmeal, whole grain breakfast cereal, bran or popcorn)? A serving is one slice of bread, 1 ounce of breakfast cereal or ½ cup of cooked cereal, pasta or rice.
   - ☐ Yes
   - ☐ No

4. **Do you usually eat 3 servings of nuts per week?** A serving is 1 ounce, which is about one airline packet of nuts or one tablespoon of peanut butter.
   - ☐ Yes
   - ☐ No

5. **Do you eat more than 3 servings of refined starch per day** (white bread, white rice, white pasta, white potatoes or low fiber cereals

like crispy rice and corn flakes)? A serving is one slice of bread, 1 ounce of breakfast cereal or ½ cup of cooked cereal, pasta or rice.

- □ Yes
- □ No

6. **Do you usually eat butter, lard, red meat, cheese or whole milk 2 or more times per day?**
   - □ Yes
   - □ No

7. **Do you eat stick margarine, vegetable shortening, store-bought baked goods (cookies, cakes, pies) or deep-fried fast foods on most days?**
   - □ Yes
   - □ No

8. **Do you eat oil-based salad dressing or use liquid vegetable oil for cooking on most days?**
   - □ Yes
   - □ No

9. **How many servings of alcohol do you have on a typical day?** One serving is a can of beer, a glass of wine or a shot of hard liquor.

   ____________________ servings.

10. **Do you take a multivitamin or a B complex supplement on most days?**

☐ Yes
☐ No

End of Questionnaire.

Thank you for your time.